“Correlation study on the branching pattern of foetal and adult internal iliac artery”

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In

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CERTIFICATE

This is to certify that the dissertation "Correlation study on the branching pattern of foetal and adult Internal iliac artery" is an original work done by **Dr. T. Jasmine Divya**, Post Graduate student, PSG Institute of Medical Sciences and Research, Coimbatore, under my supervision and guidance.

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DECLARATION

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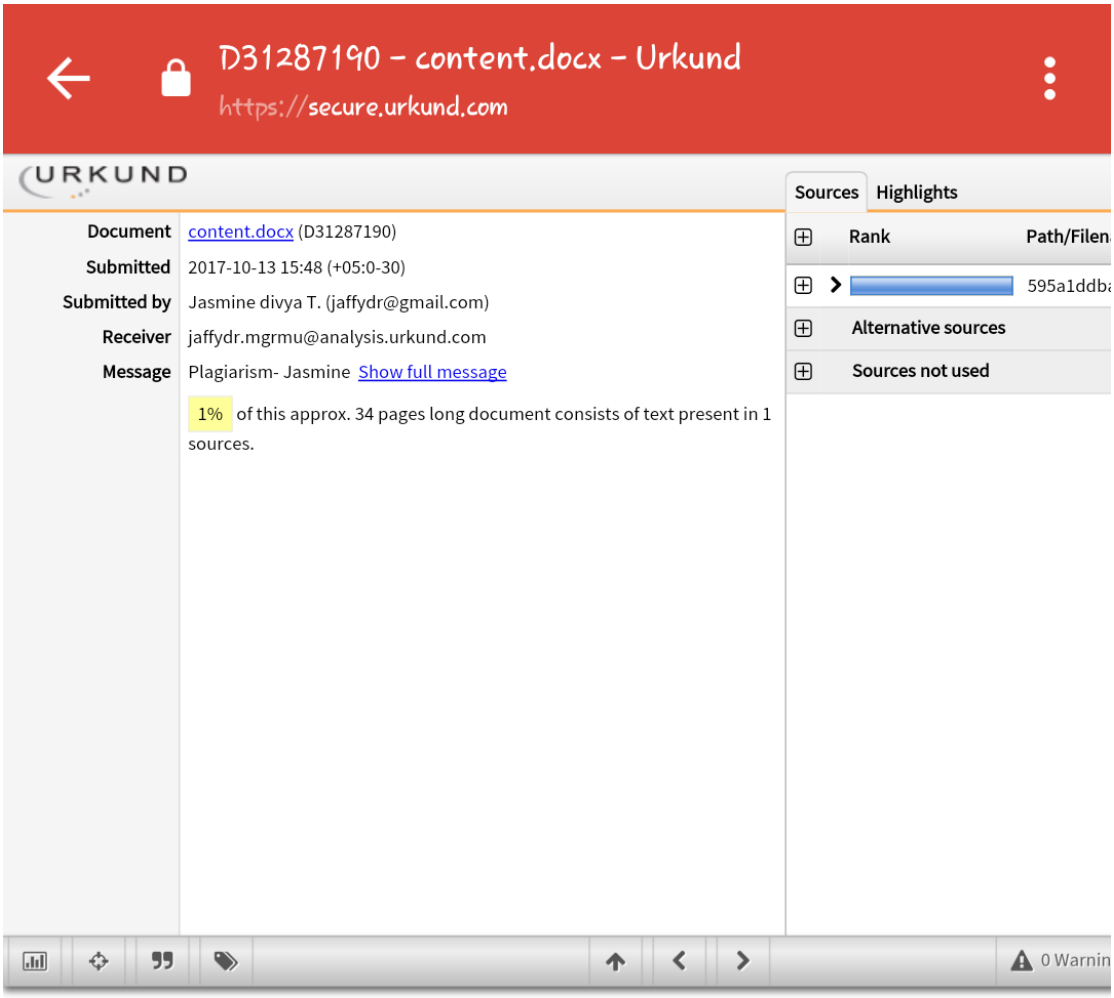

INTRODUCTION: Internal iliac artery is derived from Latin word, “Arteria iliaca interna” since it is present in the iliac region of the abdomen. Internal iliac artery is exhaled from the proteus satellite as per the Greek mythologist (Taylor2017) [52]. But in olden days, internal iliac artery is known as hypogastric artery because of its presence in the hypogastric region of pelvis. Internal iliac artery is considered as the prime artery of the pelvic region. Angio-architecture of this artery is clinically significant in many surgeries, interventional procedures and also in recent advances. The surgeries in which the internal iliac artery is important are haemorrhoids, rectal malignancy, embolus, tumors, uncontrolled postpartum haemorrhage, transurethral resection of prostate, aorto-iliac aneurysm, intractable pelvic haemorrhage, post urethral laser surgery for non-healing penis ulcer, systemic vascular disease, amputation of leg in peripheral arterial disease, total hip arthroplasty[43], endoscopic total extra peritoneal inguinal hernioplasty, Wertheim extended colpohysterectomy, tension free vaginal tape procedure. The interventional radiological procedures entailing the internal iliac artery are angiography, laparoscopic guided herniorrhaphy, and laparoscopic guided endovascular stenting in arteriosclerosis. Recent advances relating to internal iliac artery are interventional surgical procedures, investigative technique, keyhole surgeries, buttonhole incision, cryosurgical procedures and even in avascular interventions [70]. These surgeries and interventional radiological procedure involved in angioarchitecture of this artery which is clinically relevant for anatomists, surgeons, obstetrics and gynaecologists, urologists and the vascular surgeons. Despite its remarkable significance, in India very few literatures are available to learn the morphology of the branches of internal iliac artery. Hence the present study is done to fulfil this interim and helps to enhance the knowledge about the gross anatomy of internal iliac artery.

The internal iliac artery is short, compact firm vessel considerably smaller in size than the external iliac artery. It mainly supplies the pelvic walls, pelvic viscera, perineum, gluteal region and medial compartment of the

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To
Dr Jasmine Divya T.
Postgraduate
Department of Anatomy
Guide: Dr G Amudha
PSG IMS & R
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Ref: Project No.15/399

Date: December 30, 2015

Dear Dr Jasmine Divya,

Institutional Human Ethics Committee, PSG IMS&R reviewed and discussed your application dated 19.12.2015 to conduct the research study entitled *"Correlation study on the branching pattern of foetal and adult internal iliac artery"* during the IHEC meeting held on 24.12.2015.

The following documents were reviewed and approved:

1. Project Submission form
2. Study protocol (Version 1 dated 19.12.2015)
3. Confidentiality statement
4. Application for waiver of consent
5. Data collection tool (Version 1 dated 19.12.2015)
6. Permission letter from concerned Head of the Departments
7. Current CVs of Principal investigator, Co-investigators
8. Budget

The following members of the Institutional Human Ethics Committee (IHEC) were present at the meeting held on 24.12.2015 at IHEC Secretariat, PSG IMS & R between 10.00 am and 11.00 am:

Sl. No.	Name of the Member of IHEC	Qualification	Area of Expertise	Gender	Affiliation to the Institution Yes/No	Present at the meeting Yes/No
1	Mr. R. Nandakumar	BA., BL	Legal Expert, Chairperson	Male	No	Yes
2	Dr. S. Bhuvaneshwari (Member-Secretary, IHEC)	MD	Clinical Pharmacology	Female	Yes	Yes
3	Dr. S. Shanthakumari	MD	Pathology, Ethicist	Female	Yes	Yes
4	Dr D Vijaya	M Sc., Ph D	Basic Medical Sciences (Biochemistry)	Female	Yes	Yes

The study is approved in its presented form. The decision was arrived at through consensus. Neither PI nor any of proposed study team members were present during the decision making of the IHEC. The IHEC functions in accordance with the ICH-GCP/ICMR/Schedule Y guidelines. The approval is valid until one year from the date of sanction. You may make a written request for renewal / extension of the validity, along with the submission of status report as decided by the IHEC.

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Following points must be noted:

1. IHEC should be informed of the date of initiation of the study
2. Status report of the study should be submitted to the IHEC every 12 months
3. PI and other investigators should co-operate fully with IHEC, who will monitor the trial from time to time
4. At the time of PI's retirement/intention to leave the institute, study responsibility should be transferred to a colleague after obtaining clearance from HOD, Status report, including accounts details should be submitted to IHEC and extramural sponsors
5. In case of any new information or any SAE, which could affect any study, must be informed to IHEC and sponsors. The PI should report SAEs occurred for IHEC approved studies within 7 days of the occurrence of the SAE. If the SAE is 'Death', the IHEC Secretariat will receive the SAE reporting form within 24 hours of the occurrence
6. In the event of any protocol amendments, IHEC must be informed and the amendments should be highlighted in clear terms as follows:
   a. The exact alteration/amendment should be specified and indicated where the amendment occurred in the original project. (Page no. Clause no. etc.)
   b. Alteration in the budgetary status should be clearly indicated and the revised budget form should be submitted
   c. If the amendments require a change in the consent form, the copy of revised Consent Form should be submitted to Ethics Committee for approval
   d. If the amendment demands a re-look at the toxicity or side effects to patients, the same should be documented
   e. If there are any amendments in the trial design, these must be incorporated in the protocol, and other study documents. These revised documents should be submitted for approval of the IHEC and only then can they be implemented
   f. Any deviation-Violation/waiver in the protocol must be informed to the IHEC within the stipulated period for review
7. Final report along with summary of findings and presentations/publications if any on closure of the study should be submitted to IHEC

Kindly note this approval is subject to ratification in the forthcoming full board review meeting of the IHEC.

Thanking You,

Yours Sincerely,

SECRETARY
PSG IMS&R
COIMBATORE-641004.
INSTITUTIONAL HUMAN ETHICS COMMITTEE

Dr Sudha Ramalingam
Alternate Member - Secretary
Institutional Human Ethics Committee

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INTRODUCTION

Internal iliac artery is derived from Latin word, “Arteria iliaca interna” since it is present in the iliac region of the abdomen. Internal iliac artery is exhaled from the proteus satellite as per the Greek mythologist (Taylor2017) [52]. But in olden days, internal iliac artery is known as hypogastric artery because of its presence in the hypogastric region of pelvis.

Internal iliac artery is considered as the prime artery of the pelvic region. Angio-architecture of this artery is clinically significant in many surgeries, interventional procedures and also in recent advances. The surgeries in which the internal iliac artery is important are haemorrhoids, rectal malignancy, embolus, tumors, uncontrolled postpartum haemorrhage, transurethral resection of prostate, aorto-iliac aneurysm, intractable pelvic haemorrhage, post urethral laser surgery for non-healing penis ulcer, systemic vascular disease, amputation of leg in peripheral arterial disease, total hip arthroplasty[43], endoscopic total extra peritoneal inguinal hernioplasty, Wertheim extended colpohysterectomy, tension free vaginal tape procedure.

The interventional radiological procedures entailing the internal iliac artery are angiography, laparoscopic guided herniorrhaphy, and laparoscopic guided endovascular stenting in arteriosclerosis. Recent advances relating to internal iliac artery are interventional surgical procedures, investigative technique, keyhole surgeries, buttonhole incision, cryosurgical procedures and even in avascular interventions [70]. These surgeries and interventional

radiological procedure involved in angioarchitecture of this artery which is clinically relevant for anatomists, surgeons, obstetrics and gynaecologists, urologists and the vascular surgeons.

Despite its remarkable significance, in India very few literatures are available to learn the morphology of the branches of internal iliac artery. Hence the present study is done to fulfil this interim and helps to enhance the knowledge about the gross anatomy of internal iliac artery.

The internal iliac artery is short, compact firm vessel considerably smaller in size than the external iliac artery. It mainly supplies the pelvic walls, pelvic viscera, perineum, gluteal region and medial compartment of the thigh. It arises anterior to the lumbosacral articulation and runs inferiorly to the upper quarter area of greater sciatic foramen. It runs posterior to the ureters and vas deferens in males and fallopian tube and ovaries in females; anterior to the sacroiliac articulation, the origin of the piriformis muscle, internal iliac vein and lumbosacral trunk; medial to the external iliac vein, lateral to the parietal peritoneum and tributaries of internal iliac vein; superior to the obturator nerve.

The internal iliac artery divides into two main trunks namely, anterior and posterior trunk. From the anterior trunk eight branches originate in the hierarchy of inferior gluteal artery, middle rectal artery, uterine artery, obturator artery, inferior vesicle artery, superior vesicle artery, vaginal artery and internal pudendal artery. From the posterior trunk it gives off three

branches namely iliolumbar artery, lateral sacral artery and superior gluteal artery.

Among the branches of internal iliac artery, the present study is focused only on the morphological structure of superior gluteal artery, inferior gluteal artery and internal pudendal artery because of their variation in the origin and course.

The superior gluteal artery is a short stout branch of internal iliac artery. It is derived from the Latin word called “Arteria glutaea superior”. It is the continuation of posterior trunk of internal iliac artery. This artery has considerable clinical significance because of its involvement in many microsurgeries such as the production of superior gluteal artery perforator flap (Alain R. Gagnon 2006) [23], superior gluteal artery rotation flap for treating lumbosacral wounds (James Robert Wendt et.al 1998)[75] and also in transcatheter angiographic embolization procedure (Eric K. Hoffer 2008)[27].

The superior gluteal artery runs posteriorly from its origin between lumbosacral trunk and first sacral nerve and gives out three tiny muscular branches for its supply to iliacus muscle, piriformis muscle and obturator internus muscle, before it enters into the uppermost part of greater sciatic foramen to supply gluteus maximus muscle, gluteus medius muscle, gluteus minimus muscle and tensor fasciae lata. Before entering into the greater sciatic foramen, it gives off an important branch to iliac bone to supply nutrition therefore the branch is called as nutrient artery. After it passes through the

greater sciatic foramen to reach the gluteal region; where it settles on the upper part of piriformis muscle. Here, undercover of gluteus maximus muscle it subdivides into superficial and deep branch.

The superficial branch of the superior gluteal artery supplies the gluteus maximus muscle by reaching through the posterior surface of the muscle which gets anastamose with inferior gluteal artery and lateral sacral artery. The deep branch supplies the gluteus medius muscle by reaching the posterior surface of the muscle where it subdivides into superior and inferior division. The superior division runs along the superior border of the gluteus minimus muscle to reach the anterior superior iliac spine (ASIS) of iliac bone, and forms anastomose with the deep iliac circumflex artery and the ascending branch of the lateral femoral circumflex artery. The inferior division pierces the gluteus minimus muscle in oblique manner and passes to reach the greater trochanter of femur to supply hip joint. The inferior division gets anastomose with the lateral femoral circumflex artery.

The inferior gluteal artery is the largest branch of anterior division of internal iliac artery. It is derived from the Latin word called "Arteria glutaea inferior". Historically, the inferior gluteal artery is otherwise called as sciatic artery. The inferior gluteal artery is involved in various operations such as perforator flap in reconstructive breast surgery (Moustapha Hamdi 2006) [24], selective embolization in pelvic injury (Woong Yoon et.al 2004) [78], vascular replacement of hip joint in case of head of femur fracture (william J.Hozack

et.al 2009), postpartum haemorrhage (C.B-Lynch et.al 2006) [10] and rectal cancer (Nunoo-Mensah JW et.al 2007) [40].

The inferior gluteal artery is distributed mainly to the gluteal region and posterior compartment of the thigh. It descends posterior to the lumbosacral plexus and anterior to the piriformis muscle. It passes behind the internal pudendal artery to reach the inferior part of greater sciatic foramen and leaves the pelvic cavity. It settles in the interval between the lower border of piriformis muscle and upper border of coccygeus muscle. It then runs inferiorly between the greater trochanter of the femur and tuberosity of the ischium, which is accompanied by the sciatic nerve and posterior femoral cutaneous nerve and the gluteus maximus muscle forming the hood. It further descends to the posterior compartment of the thigh to perfuse the skin in that region via cutaneous branch and finally anastomose with first perforating artery which is a branch of femoral artery.

The internal pudendal artery is the last branch of anterior trunk of internal iliac artery. It is derived from the Latin word called “Arteria pudenda interna” which gives a meaning “to be ashamed of”. It supplies external genitalia. It is smaller in female than male. This artery has considerable clinical significance because of its involvement in many operative and interventional procedures such as construction of fascio cutaneous flap in the vulvovaginal area of females (W. Oosterlinck et.al 2002)[50], in chronic kidney disease patients reconstruction of the calcified artery, Zentrial interventional procedure in restoring erectile dysfunction (N.N. Khannaa et.al 2015)[35], endovascular

stent for atherosclerosis, pelvic arterial haemorrhage in pelvic fracture, perforator island flap for benign rectovaginal fistula in post obstetric injury, crypto glandular sepsis (Haitham H. Khalil et.al 2016)[34] and stereotactic body radiotherapy procedure.

The branches of internal pudendal artery are distributed over the external genitalia and perineum. It descends on the lateral pelvic wall and passes through the lower part of greater sciatic foramen; thereby it leaves the pelvic cavity and reaches the inferior part of piriformis muscle to enter into the gluteal region. It winds around the sacrospinous ligament and passes through the lesser sciatic foramen to supply the perineal region. It travels through the Alcock's canal (also called pudendal canal) along with the internal pudendal veins and the pudendal nerve.

The internal pudendal artery gives off two pairs of common branches and four pairs of uncommon branches for males and females to supply perineum. The two pairs of common branches are inferior rectal artery and perineal artery. The four pairs of uncommon branches are posterior labial artery or posterior scrotal artery; artery to bulb of vestibule or artery to bulb of penis; dorsal artery of clitoris or dorsal artery of penis and deep artery of clitoris or deep artery of penis. In males; it gives off many tiny perforating branches to penis.

The accidental haemorrhage is common due to the erroneous interpretation of the various arteries. Usually arterial branching pattern shows a

wide range of variation. Among all the arteries, morphology of superior gluteal, inferior gluteal and internal pudendal arteries are the least focused arterial variation even though it holds the high range of clinical significance. According to the guidelines of Modified Adachi classification (Yamaki) [76], these three branches of the adult internal iliac artery are classified into 5 different types based on their origin and extension.

The variations in the vascular pattern of the branches of the adult internal iliac artery are frequently quoted due to their embryological modification. In India, very few literatures are available to show the different patterns in the morphology of foetal internal iliac artery and its branches. But in Tamilnadu population, there was no study available about the different patterns in foetal branches of foetal internal iliac artery. Hence present study is done to study the frequency of various branching patterns in the foetal internal iliac artery.

The knowledge about the foetal internal iliac artery is much needed in operative and interventional procedures namely surgical resection of sacrococcygeal teratoma, congenital persistent umbilical artery, preoperative placement of internal iliac artery Balloon catheter under fluoroscopy, embolization and radiofrequency ablation. Sometimes the immature vascular architecture causes aneurysmal formation in the iliac arteries.

Because of their clinical significance, the development of pelvic vasculature of foetal internal iliac artery is needed to be learned in detail. The

adult pattern of angioarchitecture is developed in the third month of intrauterine life. The circulation of blood starts at the fourth month of intrauterine life. In foetus, internal iliac artery is double the size of external iliac artery.

The umbilical artery develops from the left primitive dorsal aorta when the foetus is less than 1.5mm length and gives rise to superior vesicle artery. The developed umbilical artery in the embryonic life of human foetus made a link with fifth lumbar intersegmental artery during fourth week of intrauterine life. Disappearance of a part of the umbilical artery present between the dorsal aorta and the above mentioned anastomosis with the fifth lumbar intersegmental artery. The part of fifth lumbar intersegmental artery present between the dorsal aorta and the point of communication of umbilical artery with the fifth lumbar intersegmental artery which results in the formation of common iliac artery. So the iliac artery is the continuation of umbilical artery. The part of fifth intersegmental artery present beyond the communication with umbilical artery forms into internal iliac artery.

The continuation of common iliac artery is the internal iliac artery. The development of internal iliac artery occurs when the embryo is 4mm long and the fifth lumbar intersegmental artery develops into internal iliac artery. The proximal part of umbilical artery forms superior vesicle artery; but its distal part gets obliterated to develop into medial umbilical ligament during the third or fourth month of intrauterine life. The fate of all the branches of the internal

iliac artery have its origin from fifth intersegmental artery which is also called as axial artery of lower limb.

Developmentally, the branches of internal iliac artery in foetus appear different from the adult branches of internal iliac artery. The foetal internal iliac artery has two main trunks which are superior vesicle artery and inferior gluteal artery. The inferior gluteal artery is the axial artery of lower limb.

The foetal branching pattern is highly variable which determines the pattern in adults. So the present study is done to study the frequency of foetal arterial pattern in the branches of internal iliac artery on superior gluteal artery, inferior gluteal artery and internal pudendal artery. The type of pattern in these three branches is classified using the Piersol classification [51] into 4 types which is based on the branching pattern and course.

In cadaveric specimen, pelvic vascular anatomy is very difficult to evaluate. Using new diagnostic technique like Contrast-enhanced CT of pelvic arteriogram gives better understanding and easy evaluation for the branches in the arterial pattern of internal iliac artery (Tiago Bilhim 2010) [6]. The CT of pelvic arteriogram is considered as the gold standard method and is the principal diagnostic and investigative procedure before doing any surgical operations in the pelvic region. For this study Multi slice spiral CT is used to get arteriogram images. The arteriogram obtained for the study is also classified based on Modified Adachi guidelines [76]. These three branches of the

internal iliac artery obtained from arteriogram are classified into 5 different types based on their origin and distribution.

The purpose of the study is to correlate the three branches of internal iliac artery obtained from different modalities for better understanding of angioarchitecture and their anatomical variations. In India, till today no literature was found; thus used different modalities to evaluate the branching patterns of internal iliac artery. In order to fulfil this lacuna the present study is done on Tamilnadu population, to study the frequency of adult and foetal internal iliac artery branches by dissection method and to evaluate the frequency of the adult internal iliac artery branches by angiogram method.

AIM

To study the different types in the branching pattern of internal iliac artery among the population of Tamilnadu on adult cadaveric specimens, spontaneously human aborted foetuses and pelvic arteriogram images.

OBJECTIVES

- ✓ To study the type of branching pattern of internal iliac artery in adult cadaveric specimens.
- ✓ To study the type of branching pattern of internal iliac artery in the spontaneously aborted human foetus specimens.
- ✓ To study the angioarchiectural type of branching pattern of internal iliac artery from the retrospective images of CT arteriogram.

REVIEW OF LITERATURE

According to Standring S et al, in Gray's Anatomy published on 2008, the internal iliac artery is the vital artery that supplies the pelvic and perineal organs such as the rectum, urinary bladder, pelvic walls, posterior abdominal wall, prostate, seminal vesicle, erectile tissues in males and females and adductor compartment of the thigh. It also supplies placenta in the fetus. The internal iliac artery divides into anterior and posterior divisions and these divisions give rise to various parietal and visceral branches. There were usually no branches arising from the main stem of the internal iliac artery. Anterior division of the internal iliac artery gives rise to several visceral branches namely, the superior vesical artery, the inferior vesical artery, the middle rectal artery and the uterine artery. In females, the vaginal artery replaces the inferior vesical artery. The parietal branches arising from the anterior division are the obturator artery, the inferior gluteal artery and the internal pudendal artery. All the branches from the posterior division are parietal. They are the superior gluteal artery, the lateral sacral artery and the iliolumbar artery [68].

In 1918, Benjamin Lipshutz et al; conducted a comparative study on 93 pelvises from Jefferson Medical College, Philadelphia. The study consisted of 72 White males, 11 White females, 7 Black males and 3 Black females. Type I was occurred in 40 percent of the cadavers studied (28 White males, 6 White females, 3 Negro males, 1 Negro female subject). Out of the total 40 percent, 24 percent were noted on the right side of the body and 16 percent were on the

left side. In this group, the superior gluteal artery was constituted as the largest branch and aroused as the dorsal or posterior trunk of the hypogastric (internal iliac) artery; the internal pudendal (internal pudic) and the inferior gluteal arteries were originated from a common trunk caudal to the superior gluteal atery.

Type II was recorded with slight variations in 24 percent (16 White males, 3 White females, 2 Negro males, and 1 Negro female). Of the vessels observed 14 percent were seen on the right side of the body and 10 percent were found on the left side. In this type, the superior and inferior gluteal arteries aroused from the hypogastric artery in a common trunk. But the internal pudendal artery was originated as a separate branch from the caudal continuation of the hypogastric artery.

Type III was found with slight variations in 17 percent (14 White males, 1 White female, and 1 Negro male). Of the arteries classified, 10 percent were noted on the left side of the body and 7 percent were noted on the right side. In this type the superior gluteal, inferior gluteal, and internal pudendal arteries were occurred to be as the separate branches of the hypogastric artery.

Type IV was found in 11 percent (8 White males, 1White female, 1 Negro male and 1 Negro female). Of the arteries observed, 3 percent were noted on the right side of the body and 8 percent were noted on the left side. In this group, the internal pudendal, and the inferior gluteal arteries aroused from

the common trunk of the hypogastric artery. Here, the superior gluteal artery originated as a separate branch dorsal to the common trunk.

Type V was occured in 7 percent (6 White males). Out of the observed arteries, 2 percent were noted on the right side of the body and 5 percent were on the left side. In this group, the superior gluteal, inferior gluteal and internal pudendal arteries were aroused from the hypogastric artery of a common trunk. The author also concluded that the variations were due to defective arteriogenesis [38].

In 1928, Adachi et al categorized the adult pelvic arterial pattern into 5 distinct types. In Type I, the internal pudendal and the inferior gluteal arteries shared the common trunk. In Type II, the superior gluteal artery shared a common trunk with the inferior gluteal artery. In Type III, the inferior gluteal, the superior gluteal and the internal pudendal arteries took origin independently of each other from the hypogastric artery. In Type IVa, the inferior gluteal and the internal pudendal arteries shared a trunk and this trunk gave origin to the superior gluteal artery. In Type IVb, the inferior gluteal and the superior gluteal arteries shared a trunk, and this trunk gave origin to the internal pudendal artery before it branches out. In Type V, the internal pudendal and the superior gluteal arteries shared a common trunk but here inferior gluteal artery took origin independently from the anterior division of internal iliac artery [1].

The Adachi guidelines focused on the relationship between the inferior gluteal, the internal pudendal and the superior gluteal arteries. He conducted

this study as per his guidelines in 121 specimens among Japanese population, of which 51.2% belonged to type I which was found to be the most common type. Type II, III, IV and V were noted at 23.1%, 18.2%, 4.1% and 0.8% of the specimens respectively [1].

In 1929, Tsukamoto et al; conducted a study on the arterial system in the pelvic cavity of 287 cadavers among Japanese population and categorized them as per the Adachi classification into five types. The author concluded that the most common type was analyzed and observed as Type I because it was seen in 56.5% of the specimens. Type II, III and IV were noted at 8.4%, 22% and 12.9% of the specimens respectively. Type V was not seen in any of the specimens, since it was considered as the deficient type [73].

In the arrangement of branches of foetal internal iliac artery, four types were recognized by Piersol in 1930 based on the three large branches namely inferior gluteal artery, superior gluteal artery and internal pudendal artery. In type I, the internal pudendal and inferior gluteal arteries shared a common trunk from the anterior division of internal iliac artery but the superior gluteal artery took origin independently. In type II, these three vessels had taken origin separately from the internal iliac artery. In type III, superior gluteal and inferior gluteal arteries came from the internal iliac artery by a common trunk but the internal pudendal artery had a different origin from the anterior trunk of internal iliac artery. In type IV, all the three vessels were arising from a common stem [51].

In 1935, Miyaji et al; conducted a study on 179 pelvic specimens in Arbeit Mat Institute Kanazawa for ahypogastrica as per Adachi guidelines. The study revealed that 79.4% of pelvic specimens belonged to type I. The second major type was noted in this study as type II and noted in 11.7% of the specimens. Type III and IV were seen at 9.5% and 4.2% of the specimens respectively. The author concluded that the type V was recorded as the rarest variant of all the types. The author revealed that the variation in the internal iliac artery had more clinical significance. He stressed the importance of knowing about the branching pattern of adult internal iliac artery by surgeons and orthopedicians [41].

Arai et al 1936; carried out an anatomical study on 500 pelvic specimens among Japanese population, about the adult pattern of distribution of hypogastric artery. The author found that type I was perceived as the majority type and was observed in 52.4% of the specimens. Type III was the second major type and was noted in 24% among observed specimens. Type II and IV were detected at 19.4% and 4.2% of the specimens respectively. The author proved that this artery had the more variable branching pattern which was clinically significant [3].

Hoshiai et al 1938; conducted an anatomical study on 379 Japanese fetus pelvic specimens. 55.1% of the specimens were noted under type I. Type II, III and IV was noted at 16.1%, 26.1% and 2.6% of the specimens respectively. The author was confirmed that the Type V was the rarest of all.

The author concluded that the type I was the most prominent type among Japanese population [29].

In 1941, Ashley FL et al; conducted a study on the branching pattern of the hypogastric artery in American whites and blacks in 260 pelvic specimens. The author noticed that the type I was the most common among American population which was seen in 58.1% of the specimens. Type II, III and IV were noted at 17.3%, 9.6% and 7.7% of the specimens respectively. Type V was not seen on any of the specimens. The author concluded that the branching pattern of internal iliac artery was not limited among American ethnic group [4].

In 1951, Suzuki H. et al; studied about the mode of branching patterns of the internal iliac artery in 490 pelvic halves of Japanese cadavers. The author observed and analyzed that the type I was the most common, making up to 53.2% of the specimens. Type II, III, IV and V were noted at 18.8%, 24.1%, 3.7% and 0.2% of the specimens respectively. According to the author, internal iliac artery branching pattern showed much variability in Japanese populations [69].

In 1952, Braithwaite JL et al; done a descriptive study on 169 pelvic halves, among which 61 were females (27 adults and 34 infants) and 108 were males (91 adults and 17 infants). As per the Adachi guidelines, the author noted that type I was more common at 48.5% and type V was found to be the rarest. The author injected a carmine gelatin preparation of fresh material into adult pelvic arteries and Indian ink (Raven brand) was injected into the infant pelvic

arteries, prior to the dissection to trace the branching pattern of hypogastric artery [8].

In 1954, Yasukawa et al; conducted an anatomical study in Japanese populations about the hypogastric artery on 544 pelvic specimens. The author observed and analyzed that the Type I was the most frequent type, which was found to be in 53.7% of the specimens. Type II, III and IV were noticed at 18.4%, 23.9% and 4%of the specimens respectively. Type V was not seen in any of the specimens. So the type I was considered as the most significant variant type and the type V was considered as the rarest of all other types among Japanese population [77].

In 1959, Fisher et al; conducted a descriptive study on 50 pelvic specimens among German population. The author discovered that the type I was the most common, making up 50% of the specimens. Type II, III and IV were found on 26%, 16% and 8% of the specimens respectively. Type V was not seen in any of the specimens. The author concluded that the type I was noted as the most common type in adult branching pattern [21].

It was a long belief that ligation of the hypogastric arteries would lead to complete cessation of blood flow in the area supplied by these vessels. Yet, owing to the activation of the anastomotic network immediately after ligation, blood was never completely drained from the hypogastric artery distal to the site of ligation. It was demonstrated by Burchell in 1968. So the author

concluded that this was a notable point of clinical importance for surgeons, vascular surgeons and orthopedicians [9].

In 1968, W. H. Roberts et al; has conducted a descriptive anatomical study on 167 pelvic halves of Caucasian cadaveric specimens. As per the guidelines of Adachi, it was noted that 51%, 26.8%, 14.4%, 7.2% of the specimens belonged to type I, type II, type III and IV respectively. There were no specimens belonging to type V. The author discovered that there was a new type of specimen, in which the origin of inferior gluteal artery found above the origin of superior gluteal and the umbilical arteries. He also noted that the internal pudendal, the vaginal and middle rectal arteries originated from a common trunk. So the author named this new variation as type VI branching pattern [57].

In 1974, Morita et al; explained in his anatomical study about the arterial system of the common iliac and the internal iliac arteries based on Piersol's study in 267 Japanese fetal pelvic halves. The author confirmed that the type I was the most common, making up 49.1% of the specimens. Type II, III and IV were noted at 22.5%, 21.7% and 6.7% of the specimens respectively. Type V was not seen in any of the specimens [42].

In 1978, Fitzgerald MJT et al in Human Embryology stated that during the vascular development, the most appropriate channels enlarged and the other vessel were undergone to retraction or disappearance, which resulted in the formation of final arterial pattern [22].

In 1980, Nicholas P Mann et al; did a case report on three infants, where unusual gluteal skin necrosis was noted after the umbilical artery catheterization. In case I and II, the catheter was placed at the level of 3rd lumbar vertebra. But in case III, the catheter was placed at the level of 2nd lumbar vertebra. Because of the catheterization, there was a development of obstruction in the superior gluteal artery and the inferior gluteal artery by means of thrombosis or embolism which was leading to vasospasm. So he concluded that it was important to examine the buttocks and the back of every baby when umbilical artery was catheterized [39].

S. Evans et al in 1985, conducted his study on 18 patients with severe obstetric haemorrhage underwent hypogastric artery ligation. 57 percent had failed hypogastric artery ligations necessitating hysterectomy. Placenta accreta accounted for six patients of whom three required a hysterectomy. Uterine laceration was the second largest cause of haemorrhage in five patients, those who required a hysterectomy after hypogastric artery ligation failed. Hypogastric artery ligation had a specific role in the management of obstetric haemorrhage, but it was not without substantial risk of failure. The author concluded the efficacy of this procedure in controlling obstetrical haemorrhage and it had been reported within a range between 42–75% [17].

Following this, a modified classification based on the Adachi classification was proposed by Yamaki et al and categorized into 5 types of branching pattern and each type had 1 to 6 groups in it. According to this classification, a study of the variability of origin of parietal branches of the

internal iliac artery stated that the inferior gluteal and internal pudendal vessels were given off by a common trunk in 63.2% of cases. When the common trunk was divided within the pelvis it came under the type Ia, which was seen in 60.6%, while the bifurcation occurred below the pelvic floor in 2.6% and it came under the type Ib [76].

Yamaki et al 1998, a new classification system designed and revised to simplify for medical purposes. In that the superior gluteal, inferior gluteal and internal pudendal arteries were defined as the major branches of the internal iliac artery and the umbilical artery was excluded from this group. The branching of the internal iliac artery was classified into 4 groups. Group A, the internal pudendal and inferior gluteal arteries shared a common trunk without the superior gluteal artery. In group B, these three vessels were originated separately from the internal iliac artery. In group C, superior gluteal and inferior gluteal arteries shared a common trunk but the internal pudendal artery had a different origin directly or from another stem of internal iliac artery. In group D, all the three vessels were arising from a common stem. Almost 80% of the specimens were included in Group A of the new classification. This type of branching seemed to be the basic branching pattern of the internal iliac artery [76].

The author examined on 645 pelvic halves of Japanese cadavers, in which 327 right sides, and 318 left sides, were dissected during 1982 -1998. 58% of these were documented as type I, which was the most prominent of all other types. The second prominent type was revealed as type III since it was

noted on 22.8% of the specimens. Type II and IV were noted at 13.6% and 5.4% of the specimens respectively. Type V was found to be in 0.2% of the specimens and so the author named it as the uncommon type [76].

In 1987, Iwasaki et al; explained in his study about the branching pattern of the fetal internal iliac artery, by employing the Adachi classification, on 251 pelvic halves among Japanese population. The author noted that type I was found in 54.2% of the specimens. Type II, III and IV were noted at 19.5%, 24.3% and 2% of the specimens respectively. Type V was not seen on any of the specimens. So the author revealed that type I was found to be the most frequent type among fetuses in Japanese population [31].

In 1990, G.J. Romanes et al stated internal iliac artery as a terminal division of common iliac artery. 3 large branches arising from it were superior gluteal artery, inferior gluteal artery and internal pudendal artery. Superior gluteal artery supplied gluteus medius and maximus and sent articular branches to the hip joint. Inferior gluteal artery gave off a large branch to the deep surface of gluteus maximus. Internal pudendal artery entered the gluteal region through the lowest part of greater sciatic foramen and curved forward to enter the lesser sciatic foramen to run on the medial surface of obturator internus [58].

In 2005, Hong-Mei Ding et al; conducted a new modality study by the way of 3D reconstruction of the pelvis and its vasculature. The author performed 3D reconstruction by using a new compound made of Carboxy Methyl Cellulose (CMC) or lead oxide mass. He then perfused this compound

into three fresh adult cadavers, and noted the blood vessels and subsequently subjected it to multilayer spiral computed tomography (CT) scanning to obtain a series of thin sections. The author then converted the 2D images of the pelvis and its vasculature into 3D digitized models using Mimics 11.0. This methodology of producing 3D reconstruction was noted as an easy technique and has been applied to demonstrate the tiny pelvic vasculature for interactive anatomic teaching, or for preoperative planning in the treatment of severe pelvic injury and tissue flap designing [15].

In 2005, Partha Mukhopadhyay et al; planned to do a descriptive study on 8 emergency internal iliac artery ligations (EIIAL) done in conjunction with ovarian artery ligations or subtotal hysterectomy. Seven out of the eight procedures, were found to be successful. Hence the author proved that the emergency internal iliac artery ligation was one of the best lifesaving procedures in condition like postoperative haemorrhage after abdominal or vaginal hysterectomy, myomectomy, ruptured uterus, lower segment forceps delivery, criminal abortion case associated with lacerated injury of the uterus and broad ligament hematoma [44].

Fatu et al 2006; conducted a descriptive anatomical study on 100 specimens (60 males, 40 females) about the morphometric of the internal iliac artery in different ethnic group. The author observed the vascular variations in Romanian population the type I was the most common type in 60% of the specimens. Type II was observed in 20% of the specimens. Type III and type V were noted in 10% and 18% respectively. In this study the author concluded

that the type IV was the rare type. According to the author, type I was found predominantly in males, while type V was predominantly in females. Thus, branching types were clearly differed between the sexes [20].

In 2007, Neeta stated that the internal iliac artery supplied the pelvic walls, pelvic viscera, gluteal region and the adductor compartment of thigh. In foetus, internal iliac artery gave origin to umbilical arteries through which blood reaches the placenta for circulation. He concluded about the extra function of the internal iliac artery during foetal life which led the artery to look larger [49].

In 2007, Kumar D et al; reported a case about the variation of the obturator artery on 316 pelvises. Usually, the obturator artery was originated from the anterior division of the internal iliac artery. But in this study, the author noted that the obturator artery took origin from the posterior division of the internal iliac artery [36].

S Reddy et al 2007; revealed a rare observation during routine dissection of the right gluteal region of an adult male cadaver. The author analyzed and noted that there was absence of inferior gluteal artery. The author considered the gluteal region as an important anatomical and clinical area because of the presence of muscles and vital neurovascular bundles. They had great clinical relevance and morphological variations found in the gluteal region [56].

In 2007, Kawanishi et al; studied about the variations of the internal pudendal artery as a congenital contributing factor to the age of the onset of

erectile dysfunction among Japanese men. For this study, the author analyzed 145 men (290 hemi pelvises) with erectile dysfunction to correlate between the branching patterns of their internal iliac arteries and the onset of erectile dysfunction. The men were placed under anesthesia to eliminate psychological factors and given an intracavernosal injection of Prostaglandin E. Observations were then made regarding whether or not the injection caused a complete erectile response [32].

The author then employed Adachi's classification, whose results showed that men with Non-Type I branching patterns had a predisposition for developing erectile dysfunction about 10 years before the Type I males, and that those with an accessory internal pudendal artery developed a very late onset of the same. The author proved that there was a considerable effect on the branching pattern of internal iliac artery because of this anatomical variation on physiology [32].

In 2009, Hollinshead's functional anatomy, stated the internal iliac artery was branched and gave vascular supply to all the pelvic viscera. Some branches of this vessel were found to leave the pelvis to supply the musculature of the gluteal and the perineal regions [28].

In 2009, Fang J.F et al; reported that the transcatheter arterial embolization can be used for the management of pelvic arterial hemorrhage [19].

In 2009, De Meritt et al; described a patient with benign prostatic hypertrophy who had severe gross hematuria and was subjected to inferior

vesical artery embolization with polyvinyl alcohol particles. The patient stopped bleeding immediately after embolization and had improved urinary symptoms [13].

In 2009, Gerard J Tortora et al; stated about the internal iliac arteries were the primary arteries of pelvis. Internal iliac artery was also called as hypogastric artery. They began at the bifurcation of the common iliac arteries which was presented anteriorly to the sacroiliac joint, at the level of the lumbosacral intervertebral disc. They then passed posteromedially to descend into the pelvis, and then divided into anterior and posterior divisions. The general distribution of these arteries was found to be in the pelvis, the buttocks, external genitalia and the thighs [72].

In 2010, Sumathilatha sakthivelavan et al; conducted a correlation study on branching pattern of the fetal and the adult internal iliac artery. The study specimens consisted of 24 pelvic halves of dead born fetuses, of gestational age around 5 to 9 months. As per the Piersol guidelines, the dissected pelvises of aborted fetuses were categorized into 4 major types. In the divided types, type I was found to be very common in fetus and adults and it was considered as the typical distribution of the internal iliac artery. Type II and III were found to be less common. Type IV was the rarest of all [61].

The author also conducted a study in 2014 on 68 male pelvic halves and 48 female pelvic halves, for observing the variability in the branching pattern of the adult internal iliac artery among the Indian population. The author

distinguished the specimens as per Adachi's scale, type Ia was observed in 60.6%, type Ib was observed in 2.6%, type IIa was observed in 15.8%, and type III was observed in 21%. Types IIb, IV and V were not noted in any of the specimens [62].

In 2010, Tiago bilhim et al; had done a retrospective study on radiological images by using different imaging modalities on the branching pattern of the male internal iliac artery. They evaluated angio MRI, angio CT and digital angiographic images of 21 male internal iliac arteries. They classified them using the Yamaki [76] classification and found that group A was more common than other groups. They also found angio CT showed better detailed anatomy than the other 2 imaging modalities; hence they considered it as the gold standard method [6].

In 2010, Shivakumar AH et al did a study on 40 adult cadaver pelvises. Type 1 revealed to be predominant in this study and was present in 89%, type II was found in 11%. The author observed that there was absence of types III & IV of Adachi classification [66].

Richard S. Snell et al 2011 stated the right and the left common iliac arteries were the terminal branches of the aorta, which took origin at the L4 level and had a course along the medial border of the psoas muscle. Each artery terminated in front of the sacroiliac joint. The internal iliac artery had passed down to reach the greater sciatic foramen, where it divided into anterior and posterior divisions. The branches of these divisions supplied the pelvic viscera,

the perineum, the pelvic walls, and the buttocks. The branches of the anterior division were the umbilical artery, the obturator artery, the inferior vesical artery, the middle rectal artery, the internal pudendal artery, the inferior gluteal artery, the uterine artery and the vaginal artery. The branches of the posterior division were the superior gluteal artery, the lateral sacral artery and the iliolumbar artery [67].

In 2011, Shetty et al; discovered the variations in the internal iliac artery where it did not divide into anterior and posterior divisions. There were three common trunks, one for the iliolumbar and the lateral sacral arteries, another for the inferior gluteal and the internal pudendal arteries, and the third for the superior vesical and the obturator arteries. The superior gluteal and the middle rectal arteries had their origins directly from the main trunk of the internal iliac artery [65].

In 2011, T.W. Sadler stated the proximal portion of the umbilical arteries was persisted as the internal iliac artery and superior vesical arteries, whereas the distal parts get obliterated to form the medial umbilical ligament after birth of the fetus [59].

In 2011, Naveen NS et al; conducted a study on 60 dissected pelvic halves, by using the Adachi classification. The author evaluated the specimens and reported that the type I was the most common (83.5%). The author also concluded that the level of origin of the internal iliac artery was at the level of the first sacral vertebra (S1) in 58.3% of cases [46].

Surekha DS et al 2012; reported a rare case of variation in the unilateral inferior gluteal artery which was noted during regular dissections. The author revealed that there was absence of inferior gluteal artery unilaterally. The author also examined the blood supply to the gluteus maximus muscle; in this case the blood supply was taken over by a branch coming from the superior gluteal artery. According to the author, knowledge about vascular variations in the gluteal region was important for orthopedic surgeons, radiologists and anatomists since the inferior gluteal artery serves as an axial artery of lower limb.

Ramakrishnan PK et al 2012 carried out a study about the large parietal branches of internal iliac artery in two southern states. The study was conducted on 100 pelvic halves specimens (40 males, 10 females) of south Indian population with their ages between 42 to 81 years. According to the Adachi guidelines, the author categorized and observed the variations, in that type Ia was found in 26 specimens. Type Ib was found in 4 specimens. Type IIa was found in 4 specimens. But the type IIb was not seen. Type III was found in 15 specimens. Type IV was found in only one specimen. And the type V was not observed in this study [55].

The origins of the major parietal branches conformed to type I arrangement on the Adachi scale in 60 % of cases, Type III pattern was found in 30 % and type II pattern in 8 %. Type IV was less frequent and occurred in 2 % of specimens. The author concluded that these observations were important

in diagnostic and interventional radiological procedures and also in pelvic surgeries to minimize the intraoperative blood loss [55].

In 2013, Roy P K et al; conducted a study about the clinical significance in the branching pattern of internal iliac artery. For that, the author studied 20 patients with stage I cervical cancer, those who underwent Wertheim's hysterectomy over a period from June 09 to Dec 12. The author derived that there was a reduction in the internal bleeding in 80% of the patients, where the special technique of bilateral internal iliac artery ligation was used as the first step in Wertheim's Hysterectomy.

In 2013, Muktyaz Hussein et al; conducted a study among North Indian population about the variations of the internal and external iliac artery branches that could be a cause of serious medical interventions. For that, he studied on 108 hemipelves of 54 embalmed cadavers (78 male and 30 female) during routine dissection. The author found variations of obturator artery in 37.9% (41hemipelves) and normal origin from anterior division of internal iliac artery in 62.0% (67 hemipelves). Variations of internal pudendal artery in 10.1 % (11), iliolumbar artery in 9.2 % (10), inferior gluteal artery in 8.3% (9), inferior epigastric artery in 6.4% (7), lateral sacral artery in 4.6% (5) and superior gluteal artery in 1.8% (2). Unexpected presence of the variant vessels in the retro pubic region could become a matter of great concern and the findings of the study might be gainfully utilized by imaging specialists, orthopedic surgeons, urologists, gynecologists and general surgeons [30].

The textbook of Williams Obstrectrics in 2014, Cunningham G et al stated that the blood supply to the pelvis was predominantly supplied from the branches of the internal iliac artery. These branches were organized into anterior and posterior divisions. These branches were highly variable between individuals. The branches of anterior division were the inferior gluteal, the internal pudendal, the middle rectal, the vaginal, the uterine, the obturator and the umbilical arteries. The branches of posterior division extended to the buttocks and the thighs, which included the superior gluteal, the lateral sacral and the iliolumbar arteries. To reduce hemorrhage from pelvic vessels, ligation of one or both of the internal iliac arteries had been used for many years [12].

In 2014, Moore K.L. et al; stated the internal iliac artery was the principal artery of the pelvis, which supplied most of the blood to the pelvic viscera and some to the musculoskeletal part of the pelvis. However, it also supplied branches to the gluteal region, the medial thigh regions and the perineum. Each internal iliac artery was approximately 4 cm long which was continued from the common iliac artery and then bifurcated into the internal and the external iliac arteries, at the intervertebral disc between L5 and S1 vertebrae. The ureter crossed the common iliac artery, or its terminal branches, at or, immediately distal to the bifurcation. The internal iliac artery was separated from the sacroiliac joint by the internal iliac vein and the lumbosacral trunk. It descendend posteromedially into the lesser pelvis, that was found medial to the external iliac vein and the obturator nerve and lateral to the peritoneum [33].

As the internal iliac artery reached the superior edge of the greater sciatic foramen, it divided into anterior and posterior divisions. The anterior division of the internal iliac artery were the mainly supplies to the pelvic viscera. These were the umbilical artery, the obturator artery, the inferior vesical artery, the uterine artery, the vaginal artery, the middle rectal artery, the internal pudendal artery, and the inferior gluteal arteries. The branches from the posterior division were the superior gluteal artery, the lateral sacral artery, and the iliolumbar artery [33].

Pavan P Havaldar et al 2014; had done a descriptive study on 50 adult human pelvic halves were procured from embalmed cadavers. The author observed that the middle rectal artery took origin from the anterior division in 42 specimens (84%), most frequently with internal pudendal artery in 32 specimens (64%) and was absent in 8 specimens (16%). The obturator artery took origin most frequently from the anterior division of internal iliac artery in 36 specimens (72%), from posterior division in 9 specimens (18%), from external iliac artery in 1 specimen (2%) and from inferior epigastric artery in 3 specimens (6%). The superior vesical artery, inferior vesical artery, uterine artery, vaginal artery and superior gluteal artery were found to be constant in their origins and course. The author concluded that the branches from the anterior division of internal iliac artery showed multiple variations, knowledge about these variations were very helpful in pelvic surgeries [25].

In 2014, Masoumeh Faghani et al; reported a case with variations in the branching pattern of the adult male right internal iliac artery. The author

noticed during routine dissection for undergraduates, that the anterior division's branches were the umbilical, the inferior vesical and the obturator arteries and that the posterior division's branches were the iliolumbar, the lateral sacral, the internal pudendal and the superior and inferior gluteal arteries [18].

Heung Kee Eun et al 2014 found a rare case of uncommon branching pattern of the inferior gluteal artery in a 39-year-old korean male cadaver. On the left gluteal region, the inferior gluteal artery gave muscular and articular branches at the inferior margin of superior gemellus during its extrapelvic course. The inferior gluteal artery descended in the company of the sciatic nerve and the inferior gluteal nerve, sent 3 muscular branches posterolaterally to the gluteus maximus. These 3 muscular branches were descended downwards in parallel with one another. An articular ramus crossed superficially to the sciatic nerve and continued medially running between the superior gemellus and the obturator internus. During its course, another muscular branch diverged from the articular branch. The articular branch travelled dorsally across the obturator internus and the inferior gemellus and met the medial circumflex femoral artery in the interval between the inferior gemellus and the quadratus femoris. The vessel formed from the anastomosis between the inferior gluteal artery and the medial circumflex femoral artery is connected to the gluteus maximus muscle. Another muscular branch diverged from the articular ramus of the inferior gluteal artery and arose from the inferior gluteal artery at the inferior margin of the superior gemellus. The author concluded that the knowledge of vascular variations in the gluteal region

gave useful information of versatile flaps for reconstruction. In this case, the vascular variations were good enough to consider the existence of the anastomosis between the medial circumflex femoral artery and the inferior gluteal artery as normal, not rudimentary [26].

In 2014, Waseem Al Talalwah et al; conducted a study on 171 dissected cadavers which consisted of 92 males and 79 females. The author employed as per the Adachi guidelines, the percentages as 36.1%, 5.3%, 34.8%, and 2.3% for Types I, II, III and IV of the pelvic specimens respectively. The author also noted that Type V was not found in this study. The author concluded that this study was vital for radiologists, orthopedicians, surgeons, obstetricians, gynecologists and urologists in order to avoid iatrogenic trauma [2].

Sunitha Vinnakota et al 2014 had done a case study on the variation in the branching pattern of internal iliac artery on 60 year old male cadaver during routine undergraduate dissection. The author reported that superior gluteal and inferior gluteal arteries took origin from a common trunk, and noted that the inferior gluteal artery arose separately from the anterior division of internal iliac artery which was found to be a rare variant of type IIa of Adachi's classification. The author concluded that this knowledge would be helpful for the radiologists and the surgeons to avoid accidental hemorrhage during pelvic surgeries [74].

Sumathilatha sakthivelavan et al 2014 reported a variation in 70 year old male adult cadaver which was similar to the type IIa of Adachi guidelines. The

author observed that superior and inferior gluteal arteries took origin from the common trunk whereas the internal pudendal artery originated independently from a direct branch of anterior division of the internal iliac artery [62].

In 2015, Schoenwolf GC et al; stated the right and the left umbilical arteries developed from the connecting stalk, early in the fourth week. From that new embryonic vasculature was initiated. These arteries developed an initial connection with the paired dorsal aortae in the sacral region. However, during the fifth week, these connections were obliterated and the umbilical arteries developed a new connection with the fifth pair of the lumbar intersegmental artery branches, called the internal iliac arteries. The internal iliac artery gave the vascular supply to the pelvic organs and the lower extremity limb bud [63].

In 2015, Andre´ Moreira de Assis et al; conducted a retrospective study on pelvic arterial anatomy relevant to prostatic artery embolisation and proposed for angiographic classification. For this study, 143 prostatic artery embolisation procedures were reviewed. The author classified these procedures into five subtypes based the origin of the inferior vesical artery. Type I: inferior vesical artery took origin from the anterior division of the internal iliac artery, from a common trunk with the superior vesical artery; type II: inferior vesical artery took origin from the anterior division of the internal iliac artery, inferior to the origin of superior vesical artery; type III: the origin of inferior vesical artery developed from the obturator artery; type IV: inferior vesical artery was branched directly from the internal pudendal artery; and type V: less common

origins of the inferior vesical artery. Incidences were calculated by percentage [5].

Out of Two hundred eighty six pelvic sides, 267 (93.3%) were classified into I-IV types. Among them, the most common origin was type IV (n=89, 31.1%), followed by type I (n=82, 28.7%), type III (n=54, 18.9%), and type II (n=42, 14.7%). Type V anatomy was seen in 16 cases (5.6%). Double vascularization of independent prostatic branches in one pelvic side was seen in 23 cases (8.0%). The author concluded that the four main patterns were corresponded to almost 95% of the cases, despite of the large number of anatomical variations in male pelvis. The author also evaluated the anatomic variations in a systematic fashion which was followed from a standard classification that would make prostatic artery embolisation a faster, safer, and more effective procedure [5].

Akshara Venmalassery Rajive et al 2015 carried out an anatomical study on 50 dissected pelvic halves. Of the 50 pelvic halves, the obturator artery took origin from the anterior division of internal iliac artery in 27 specimens. Remaining 23 specimens were showed its origin from multiple sources. The origin of the obturator artery was from the inferior epigastric artery in 11 cases, from the common stem of the internal iliac artery and the external iliac artery in 2 cases each, from the posterior trunk of the internal iliac artery in 5 and one each from superior gluteal, inferior gluteal, and internal pudendal artery. The author indicated that the origin of the obturator artery is highly variable. It took origin from the stem of the internal iliac artery or from its anterior or posterior

division, or from one of the branches of the divisions. It could also take origin from external iliac artery or its inferior epigastric branch. Advancements in diagnostic and surgical techniques in obstetric procedures and urogenital interventions made it essential to have a clear-cut understanding of the vasculature in the abdomen and pelvic region [53].

In 2015, Sakthivel et al; conducted a study on 60 adult pelvic halves, during routine dissection. The author noted that the obturator artery had origin from different sources i.e., the posterior division of the internal iliac artery, the superior gluteal artery, combined with the iliolumbar artery and direct branches from the external iliac artery or the inferior epigastric artery. These observations were found to be 26.67% in males and 10% in females. The author discovered that the variation in the obturator artery led to modification in the origin of superior gluteal artery. The morphological origin of the superior gluteal artery would be important to understand the pelvic vasculature better [60].

Satheesha B. Nayak et al 2015; reported a case study of anatomic variations in the pelvic vasculature in a 70 year old embalmed male cadaver. The author noted that the iliolumbar artery took origin from the main trunk of the common iliac artery. The author also found that two lateral sacral arteries and one superior gluteal artery had their origins from the posterior division of the internal iliac artery. The superior vesical, the inferior vesical, the inferior gluteal and the internal pudendal arteries were traced from the anterior division

of the internal iliac artery. The author concluded that the anatomic variations had significance on functional, surgical and radiological aspects [47].

Guodong Zhang et al 2015; had done a prospective study on 110 male pelvic halves. The author found 114 prostatic arteries in total. In 96.4% of the cases the author noted single prostatic artery and in 3.6% cases two independent prostatic arteries. The prostatic artery had its origin from different sources such as anterior trunk of the internal iliac artery in 39.5% of cases, from the superior vesical artery in 32.6% and from the internal pudendal artery in 27.9%. The author concluded that the knowledge of the pelvic vasculature was essential for surgeons to perform prostatic artery embolization [79].

In 2016, Waseem Al Talalwah et al; carried out a study in 208 hemi-pelvises. The author noted that 10.9% of the dissections had the obturator artery and its accessory was traced over the superior rami of the pubic bone. The internal iliac artery had its origin from the external iliac artery in 9.8% of the cases, and the femoral artery in 1.1% of the cases. The author found that 12% of the Austrian population had corona mortis. The knowledge about these variations would be very helpful to avoid massive bleeding in pubic rami fractures and gave awareness for the surgeons during herniorrhaphy and hernioplasty of inguinal and femoral hernia. Therefore, the obturator or accessory obturator artery which crossed over the superior pubic ramus was highly susceptible injury in either scalpel dissection or mesh insertion. In addition, gynecologists and obstetricians had awareness about the vascular variations to avoid postsurgical complications in cases of hysterectomy, in

orthopedics in cases of superior pubic rami fracture (anterior pelvic fracture), in physicians to avoid intrapelvic bleeding due to iatrogenic fault which resulted in the formation of lacerating corona mortis. So, a great precaution should be taken prior to any surgical interference at the retropubic region such as hernia repair, internal fixation of pubic fracture and skin flap transplantation [2].

A case of trifurcation of the posterior division of internal iliac artery was reported by Satheesha B. Nayak et al 2016, in which the posterior division gave rise to the lateral sacral artery, the superior gluteal artery and a common trunk. The uniqueness of the variant described in this case lies in the branching of the inferior gluteal artery and the internal pudendal artery. The stellate branching pattern, including the common trunk and two muscular branches, were observed in the gluteal region. Branching of the inferior gluteal artery and the internal pudendal artery outside the pelvis had been reported in the literature previously but, to the best of our knowledge, this stellate pattern of branching had not been reported before the current combination of variant branches including a stellate artery in the gluteal region, an abnormal obturator artery and its unusual branches had not been reported previously. The large stellate artery under the gluteus maximus muscle could cause bleeding during posterior approaches to the hip joint and also in hipbone fractures. Unusual identification of branches of the abnormal obturator artery could get damaged during prostate surgeries [48].

Jeff chase 2016, studied about the variation in the branching pattern of adult internal iliac artery on 176 hemipelves (92females, 82males). Out of 176

specimens, in 48.3% inferior gluteal and internal pudendal arteries shared a common trunk; 23.8% had independent internal pudendal artery; 7.9% had independent inferior gluteal artery. 1.1% showed independent superior gluteal artery. The author found that the angioarchitecture of pelvis showed more significant variation [11].

In 2016, Satheesha Badagabettu Nayak et al; found two variations in the male left internal iliac artery, during routine cadaveric dissection. From the left internal iliac artery, two common trunks were found to take origin and they branched into the middle rectal artery, inferior vesical artery and superior vesicale artery. The bigger common trunk gave rise to an unnamed artery, the lateral sacral artery and the superior gluteal artery. The smaller common trunk passed through the greater sciatic foramen, to enter the gluteal region by passing below the piriformis muscle, and showed a star shaped branching pattern, which was traced deep to the gluteus maximus muscle. The internal pudendal artery, the inferior gluteal artery and the two muscular arteries, were the four arteries that took origin from the star shaped branching pattern [47].

Savitha kumari et al 2016; had done a study on 50 bisected pelvises from embalmed human cadavers of both genders. The internal iliac artery was identified and classified based on the modified Adachi classification (Yamaki) [76]. The author revealed that type Ia was common and more prominent among south Indian population. Out of 50 adult human pelvis specimens, Type 1a arrangement was noted in 68% of specimens, Type II in 10%, Type III in 16% and Type IV in 6%. Type V was not found in any specimens. The author

concluded that the study of these variations might be helpful in avoiding the surgical and accidental iatrogenic injuries of the blood vessels [37].

In 2016, Vishwajit Deshmukh et al; observed a rare variation in superior gluteal artery in a female cadaver of approximately 55 years of age during a routine dissection. The left obturator artery had its origin from the superior gluteal artery inside the pelvic cavity and travelled along the lateral pelvic wall before it got entered into the obturator canal, which was related inferiorly with the obturator nerve and the left obturator vein drained into the external iliac vein. The author concluded that knowledge of such variations was necessary during hernia procedures, ligation of the internal iliac artery and muscle graft surgeries. The author also concluded that the anatomical information regarding the pelvic vasculature was also important while performing superior gluteal muscle grafts in female breast augmentation surgeries [14].

In 2017, Julius Sama Dohbit et al; conducted a retrospective cohort study regarding the uterus preserving surgery, versus hysterectomy, in the treatment of refractory postpartum hemorrhage. The author studied 24 cases of uterus preserving surgery and 36 cases of hysterectomy which done because of uterine rupture or uterine atony. By various methods, uterus preserving surgeries were performed, consisting of seven bilateral hypogastric arteries ligations, seven hysterorraphies, six bilateral uterine artery ligations, three B-Lynch sutures and one T sirulnikov triple ligation. Out of 36 hysterectomies performed, 26 were subtotal hysterectomies and 10 were total hysterectomies. The author found that the uterus preserving surgeries had more maternal deaths

and postoperative infections. Based on his study, the author concluded that hysterectomy was the safest method than uterus preserving surgery. According to the author, the knowledge about the angioarchitecture of pelvic vascular anatomy had lot of clinical relevance in doing surgeries like bilateral hypogastric arteries ligations, hysterorraphies, bilateral uterine artery ligations, B-Lynch sutures, T sirulnikov triple ligations, subtotal hysterectomy and total hysterectomy [16].

In 2017, April T. Bleich, MD et al; conducted a study on the posterior division of internal iliac arteries on 54 female cadavers, average length of the observed internal iliac artery was 27.0 (range=0-52) mm. Posterior division arteries arose from a common trunk in 62.3% of pelvic halves. In the remaining specimens, branches had took origin independently from the internal iliac artery, with the iliolumbar noted as the first branch in 28.3%, lateral sacral in 5.7%, and superior gluteal in 3.8%. The average width of the first branch was 5.0 (range=2-12) mm. In all dissections, posterior division branches had took origin from the dorsolateral aspect of internal iliac artery. The internal iliac vein was present lateral to the artery in 70.6% (12 of 17) of specimens on the left and 93.3% (14 of 15) on the right. The author concluded that ligation of the internal iliac artery 5 cm distal from the common iliac bifurcation would spare posterior division branches in the vast majority of cases. He also concluded that the internal iliac artery anatomy was essential to minimize intra-operative blood loss [7].

In 2017, Chongtham Rajlakshmi et al. conducted a morphologic and morphometric study on 44 pelvic halves (10males and 12females), of full term fetuses among Manipuri population. The author observed 40.9% of type I among males and 36.4% of type IV among females. Average length of the artery from the umbilical ring to the aortic bifurcation, from the right and left side was noted as 7.3± 0.35 and 7.4± 0.29 respectively [54].

Vincent Tatco et al. 2017 had done study on the variation in the superior gluteal artery since it was considered as the largest branch of the internal iliac artery and involved in the blood supply to structures within the pelvis and gluteal region. The author reported that the origin of superior gluteal artery might be from the internal iliac artery directly or from the internal pudendal artery. The superior gluteal artery could be injured during pelvic trauma which may lead to pseudoaneurysm sometimes. The author stressed the importance of understanding the variable angioarchitecture of internal iliac artery [70].

Huban Thomas R et al 2017, observed vascular variation of gluteal arteries during the routine dissection for the undergraduate students. The author noticed that in about 2/40 specimens (5%), inferior gluteal artery was totally absent and a branch from trunk of superior gluteal artery were replacing the distribution of inferior gluteal artery to gluteal region. He also suggested that the wide range of variations of pelvic vasculature in its distribution evaluated as per Adachi scale [71].

Nataraj KM et al 2017; carried out an anatomical study on 50 adult human pelvic halves. The author employed modified Adachi classification and observed that, type Ia in 52% of the specimens, type III in 34%, type II and V in 2% each. Type Ib and IV was not found in any of these specimens. The author also found that the absence of inferior gluteal artery in 10% of the specimens. According to the author, origin of middle rectal artery was not constant. The author concluded that the knowledge about the variation in the branching pattern of internal iliac artery showed more clinical significance [45].

In 2017, A. Senthamizh chelvan et al, conducted a study on 50 embalmed adult human halves were procured. Based on modified Adachi classification, out of 50 specimen observed, Type Ia was found in 56% of the specimens, Type Ib in 12 % of the specimens, Type II was found in 8% of the specimens, Type III was found in 20% of the specimens, Type IVa was found in 4% of the specimens, Type IVb and Type V was not found in any of the specimens. So, the knowledge about the variation in the internal iliac artery was needed during pelvic surgeries [64].

MATERIALS AND METHODOLOGY

ETHICAL CLEARANCE:

After obtaining the approval from the IHEC (Institutional Human Ethics Committee) of PSG Institute of Medical Sciences & Research for dissertation, the plot was framed for the descriptive study about internal iliac artery on.

1. Adult wet pelvic specimens.
2. Spontaneously aborted foetal specimens.
3. Images of CT (computed tomograms) pelvic arteriogram.

SAMPLE SIZE:

The sample size was 250, which was collected as following:

SL.NO.	MATERIAL	NUMBER	SAMPLE SIZE
1.	ADULT WET BISECTED PELVIS	25	50
2.	ABORTED FETUSES	50	100
3.	CT PELVIC ARTERIOGRAM IMAGES	100	100
	TOTAL		**250**

SAMPLE INCLUSION AND EXCLUSION CRITERIA:

INCLUSION CRITERIA:

ADULT WET PELVIC ASSESSMENT:

- Normal pelvic specimens.
- Irrespective of sex and age.
- Non disruption of internal iliac artery branches.

ABORTED FETUSES ASSESSMENT:

- Spontaneously aborted foetuses of gestational age from 20 weeks to 40 weeks.
- Foetuses without any congenital malformation of pelvis.
- Foetuses without any arteriovenous malformations.
- Non disruption of internal iliac artery branches.
- Foetuses without any pelvic pathology.

CT PELVIC ARTERIOGRAM IMAGES:

- Normal pelvic arteriogram without any pathology.
- CT pelvic arteriogram without any collateral vascular formation
- Pelvic arteriogram of patients above 18 years of age.

EXCLUSION CRITERIA:

ADULT WET PELVIC ASSESSMENT:

- Fracture of the pelvic bone along with soft tissue injury.
- Damage in the vascular anatomy of internal iliac artery.

ABORTED FETUSES ASSESSMENT:

- Spontaneously aborted foetuses of gestational age less than 20 weeks.
- Macerated foetuses.
- Foetuses with congenital malformation syndrome of pelvis.
- Foetuses with arteriovenous malformations.
- Disrupted internal iliac artery branches.

CT PELVIC ARTERIOGRAM IMAGES:

- Age less than 18 years.
- CT pelvic arteriogram with aneurysm, thrombus, emboli, calcification, metastasis.
- CT pelvic arteriogram with collateral vascular formation.
- CT pelvic arteriogram with large metastasis of the pelvic organs.

a) ADULT WET PELVIC SPECIMENS:

MATERIALS:

The following materials were used to dissect the adult cadaveric wet pelvic specimens:

1) Glycerine
2) Water
3) Cotton
4) Movable procedure light
5) Straight and curved artery forceps
6) Scalpel
7) Teaser
8) Toothed and non-toothed forceps
9) Apron
10) Gloves
11) Mask
12) Cap
13) Token numbers.

50 Cadaveric adult wet half pelvic specimens were collected from the dissection hall of Anatomy Department, PSG Institute of Medical Sciences & Research. Then these specimens were grouped based on sex determination. Sex determination of adult wet half pelvises were analysed based on presence of internal and external genital organs.

METHODOLOGY:

In 50 (43males, 7females) adult wet bisected pelvic specimens, the internal iliac artery was traced and morphology and branching pattern were noted. The present study was done based on the Modified Adachi classification [76]. This study mainly focused on the three large branches of internal iliac artery namely superior gluteal artery, inferior gluteal artery and internal pudendal artery. In this study 5 different branching patterns of internal iliac artery was noted and analysed based on its anatomic location and distribution

ANATOMIZATION:

The pelvis was approached via the abdominal cavity. These were the steps followed in the dissection of the adult bisected wet pelvis.

All the collected bisected pelvic specimens were given with token numbers from 1 to 50. The abdominal aorta and inferior vena cava were exposed. The common iliac artery was traced at the terminal bifurcation of aorta infront of lumbosacral joint by dissecting the compact connective tissue present over it with the help of scalpel and toothed forceps. The covering of retroperitoneal fat over the ureters, and the psoas major muscle were noted. This tissue layer could be very thick in obese cadavers. Removal of retroperitoneal pad of fat and pushing of ureter to the opposite side of the pelvis was done during fine dissection. The bifurcation of the common iliac artery on either side as internal and external iliac branches was traced with the aid of non-toothed forceps, teaser and straight artery forceps. The internal iliac vein present anterior to the internal iliac artery was excised with scalpel and non-

toothed forceps to view the branches of internal iliac artery. The superior gluteal artery was traced up to the upper part of greater sciatic foramen where it passed along the upper border of the piriformis muscle with the help of curved artery and straight artery forceps.

With the assistance of curved artery forceps and teaser, the inferior gluteal and internal pudendal arteries were tracked down in undermine of the pelvic cavity and chased down its extension through the lower quarter section of greater sciatic foramen. In relation to the piriformis muscle and pudendal nerve the extension of these two arteries were hunted down till their destination with the aid of straight artery forceps. Finally the type of arterial pattern was documented.

b) ABORTED FOETUS SPECIMENS:

MATERIALS:

The following materials were used to dissect and trace the internal iliac artery from 100 (73males, 27females) human aborted foetuses specimens.

1. Glycerine
2. Water
3. Cotton
4. Helicon table lamp
5. Straight and curved artery forceps
6. Scalpel
7. Teaser

8. Toothed and non-toothed forceps
9. Apron
10. Gloves
11. Mask
12. Cap
13. Pointed and blunt scissors.

50 spontaneously aborted foetuses were collected from the Obstetrics and Gynaecology Department, PSG Institute of Medical Sciences & Research. Then these specimens were grouped based on sex determination. The foetal specimens were numbered using token numbers.

.**METHODOLOGY:**

In 100(73males, 27females) aborted foetal specimens, morphology of the internal iliac artery branching pattern were noted. The foetal study was done based on Piersol classification [51]. This study mainly focused on 3 large branches of internal iliac artery namely superior gluteal artery, inferior gluteal artery and internal pudendal artery. In this study 4 different angioarchitectural pattern of internal iliac artery was noted based on its anatomic location and distribution.

ANATOMIZATION:

The dissection of internal iliac artery was done using transabdominal approach. The following steps were used in the dissection of the aborted foetuses to reach internal iliac artery:

Skin incision was made on the either side of inguinal ligament by connecting the most prominent elevation of anterior superior iliac spine on either side of the iliac bone with aid of scalpel and toothed forceps. This uninterrupted incision was observed over the supra pubic region (step 1 and 2). Skin incision was made on the mid axillary line which was extended from the lower border of 10^{th} rib up to the iliac crest with the assistance of scalpel (step 4). After the skin incision, superficial fascia was exposed with the aid of curved artery forceps. Stroke incision was made over the lateral wall of abdomen on the either sides of midaxillary line with the aid of scissor (step 4). Thereby three abdominal muscles (external oblique, internal oblique and transverse abdominis muscle) were excised along with transversalis fascia (step5).

With the assistance of scissor and non-toothed forceps another incision was made on the rectus abdominis muscle in the supra pubic region. The contents of the abdominal cavity were pushed up and the intestines were clamped cut and removed near the lumbosacral angle along with the mesentery. The abdominal aorta and inferior vena cava were exposed. The terminal bifurcation of the common iliac artery was tracked near the sacroiliac joint. The connective tissue covered the ureter and psoas major muscle was excised. The ureter was nicked with the aid of scalpel near the vesicourethral junction on

either side. The tough connective tissue presented over the two vessels namely external and internal iliac artery was cleared. Then the superior vesicle artery was traced in the upper segment of urinary bladder.

By holding the superior vesicle artery near the vesicouretric junction; the superior gluteal, inferior gluteal and internal pudendal arteries were easily tracked, with the help of non-toothed forceps and straight artery forceps. The full clearance of connective tissue over these arteries was obtained by keeping the soaked glycerine cotton in the pelvic cavity for an overnight. So the next day internal iliac artery was traced. Its morphological distribution was noted and documented.

c) CT PELVIC ARTERIOGRAM IMAGES:

The study is conducted on 100 radiological images of living adults (89 males, 11females) collected from the Department of Radiology, PSG Institute of Medical Sciences & Research by using multi slice 16 spirals CT in anterolateral and anteromedial view along with GE® scanner. Its componential settings were noted as the power of 100–120 kV and 200–300 mA, matrix of 512*512 pixels, slice thickness 0.5 to 1 mm and pitch of 1.3. For the assessment of CT pelvic arteriogram, normal images were collected from PACS in retrospective manner and were confirmed with the assistance of Radiologist.

The morphology of the branches and different patterns of the internal iliac artery in 100 CT pelvic arteriogram images were assessed based on Modified Adachi classification [76] and documented.

picture 1: transverse incision was made on the lower abdomen

picture 2: shows the extension of lower abdominal incision

picture 3: shows the incison was made on the medial side of the thigh

picture 4: shows the incision was made on the lateral abdominal wall

picture 5: shows the exposure of the abdominal cavity

OBSERVATIONS

The branches of internal iliac artery were traced carefully in adult cadaveric and foetal specimens. The three branches superior gluteal artery, inferior gluteal artery and internal pudendal artery were studied and based on their morphology internal iliac artery was classified. The arteriographic images of internal iliac artery were studied and the internal iliac artery was classified based on its three main branches. The results of the present anatomical study were statistically analysed using SPSS 21 on Windows 7.

a) ADULT WET PELVIC SPECIMENS:

The adult wet pelvic specimens of the internal iliac artery were categorised into five types as per Yamaki classification [76]. They were type I, type II, type III, type IV and type V. In those types, type I again subdivided into two types, type Ia and type Ib and the type II was also subdivided into two types, type IIa and type IIb.

In type I, the superior gluteal artery took origin independently and the inferior gluteal and internal pudendal arteries had a common trunk before dividing inside (Type Ia) or outside (Type Ib) the pelvic cavity. In type II, the superior and inferior gluteal arteries had a common trunk of origin which might divide inside (Type IIa) or outside (Type IIa) the pelvic cavity, with the internal pudendal artery had an independent origin. In type III, the superior gluteal, inferior gluteal and internal pudendal arteries had their origins independently from the internal iliac artery. In type IV, the superior gluteal, inferior gluteal

and internal pudendal arteries took origin from a common stem. In type V, the internal pudendal and superior gluteal arteries had an origin from a common trunk but the inferior gluteal artery was arising from a separate origin [76].

Type	Frequency	Percentage
Ia	37	74%
Ib	2	4%
IIa	4	8%
IIb	1	2%
III	5	10%
IV	1	2%
V	0	0%
Total	50	100%

Table 1: Distribution of different types in the branching pattern of internal iliac artery in adult wet pelvic specimens

In the adult cadaveric pelvic specimens, type Ia frequency was found in 37 specimens and its incidence was 74% (fig 1); type Ib frequency was found in 2 specimens and its incidence was 4% (fig 2) (fig 3); type IIa was found in 4 specimens and its incidence was 8% (fig 4); type IIb was found in 1 specimen and its incidence was 2% (fig 5); type III was observed in 5 specimens and its incidence was 10% (fig 7); type IV was found in 1 specimen and its incidence was noted as 2% (fig 8) (fig 9) and the type V was not found among Tamilnadu population (table 1) (graph 1).

In this study, type I was found to be the most prominent type of all other types among Tamilnadu population. Type II and type III were recorded as the second prominent type. The rarest type noted in this study was type V.

The distribution of different types of internal iliac artery in male and female specimens were recorded and tabulated as follows.

Type	Frequency	Percentage
Ia	33	76.7%
Ib	2	4.7%
IIa	2	4.7%
IIb	1	2.3%
III	5	11.6%
IV	0	0.0%
V	0	0.0%
Total	43	100.0%

Table 2: Distribution of different types in the branching pattern of internal iliac artery in male adult wet pelvic specimens

Among the 43 male adult wet pelvic specimens, type Ia was found in 33 specimens; type Ib was found in 2 specimens; type IIa was noticed in 2 specimens; type IIb was seen in only one specimen; type III was observed in 5 specimens. In the study, type IV and type V was not seen (table 2) (graph2).

Type	Frequency	Percentage
Ia	4	57.1%
Ib	0	0.0%
IIa	2	28.6%
IIb	0	0.0%
III	0	0.0%
IV	1	14.3%
V	0	0.0%
Total	7	100.0%

Table 3: Distribution of different types in the branching pattern of internal iliac artery in female adult wet pelvic specimens

Among the 7 female adult wet pelvic specimens, type Ia was found in 4 specimens; type Ib was not found in this study; type IIa was found in two specimens; type IIb was not recorded at all; type IV was observed in 1 specimen. In the female cadaveric specimens, the types Ib, IIb, III and V were not noted (table 3).

The incidence of male and female spontaneously adult wet pelvic specimens were compared and documented. 33% of adult male wet specimens were recorded and 4% of adult wet female specimens were documented as type Ia. 1% of the female adult wet specimens was found to be type IV (table 3) (graph 3).

On comparing in the distribution of types in the branching pattern of internal iliac artery among male and female adult pelvic wet specimens, type Ia was predominantly seen in males (76.7%) than females (57.1%). Type Ib was noted only in males (4.7%). Type IIa was found predominantly in females (28.6%) than males (4.7%). Types IIb and III were noted only in males (2.3% and 11.6%). But type IV was noted only among females (14.3%) (graph4).

b) SPONTANEOUSLY ABORTED FOETAL SPECIMENS:

The internal iliac artery was found to be twice in size of the external iliac artery since it developed from the umbilical artery. As per the Piersol guidelines (1930) [51], spontaneously aborted foetal specimens of the internal iliac artery were categorised into four types. They were type I, type II, type III and type IV.

In type I, two large trunks had an origin from the internal iliac artery, the posterior one gave rise to the superior gluteal artery and the anterior trunk gave rise to the internal pudendal and inferior gluteal arteries. In type II, all the three vessels took origin independently from the internal iliac artery. In type III, superior gluteal and inferior gluteal arteries were arising from a common trunk, the internal pudendal artery took origin from the internal iliac artery along with its other branches. In type IV, all three vessels were arising from a common stem [51].

Type	Frequency	Percentage
I	50	50%
II	32	32%
III	18	18%
IV	0	0%
Total	100	100%

Table 4: Distribution of different types in the branching pattern of internal iliac artery in spontaneously aborted foetal specimens

The type I was found in 50 specimens and its incidence was noted as 50% (fig10); type II was found in 32 specimens and its incidence was documented as 32% (fig11); type III was observed in 18 specimens and its incidence was 18% (fig 12); type IV was not seen in foetal specimens (table 4) (graph 5).

Type	Frequency	Percentage
I	42	57.5%
II	19	26.0%
III	12	16.5%
IV	0	0.0%
Total	73	100.0%

Table 5: Distribution of different types in the branching pattern of internal iliac artery in spontaneously aborted male foetal specimens

Out of 73 male spontaneously aborted foetal specimens studied, type I was found in 42 specimens; type II was noticed in 19 specimens; type III was observed in 12 specimens. The type IV was not noted in any of the male foetal specimens (table5) (graph 6).

Type	Frequency	Percentage
I	8	29.6%
II	13	48.2%
III	6	22.2%
IV	0	0.0%
Total	27	100.0%

Table 6: Distribution of different types in the branching pattern of internal iliac artery in spontaneously aborted female foetal specimens

Out of 27 female spontaneously aborted foetal specimens studied, type I was noted in 8 specimens; type II was found in 13 specimens; type III was recorded 6 specimens; type IV was not found in the collected specimens (table 6) (graph7).

Among the male and female foetal specimens studied, type I was found to be the commonest in males (57.5%) and type II was in females (48.2%). In both male and female aborted foetal specimens type IV was not found. Type III branching pattern was observed predominantly in females (22.2%) (graph8).

c) CT PELVIC ARTERIOGRAM:

The CT pelvic arteriogram images of the internal iliac artery were categorised into five groups based on the Yamaki classification [76]. They were group A, group B, group C, group D and group E.

In group A, the superior gluteal artery took origin independently and the inferior gluteal and internal pudendal arteries were arising from a common trunk of the internal iliac artery. In group B, the superior and inferior gluteal arteries took origin from a common trunk and the internal pudendal artery had an independent origin. In group C, the superior gluteal, inferior gluteal and internal pudendal arteries had their origins independently from the internal iliac artery. In group D, the superior gluteal, inferior gluteal and internal pudendal arteries took origin from a common trunk. In group E, the internal pudendal and superior gluteal arteries had an origin from a common trunk but the inferior gluteal artery was arising independently from the branches of the internal iliac artery [76].

Group	Frequency	Percentage
A	55	55%
B	22	22%
C	19	19%
D	2	2%
E	2	2%
Total	100	100%

Table 7: Distribution of different types in the branching pattern of internal iliac artery in adult CT angiogram

Group A was found in 55 arteriograms and its incidence was 55% (CTimage:1); group B frequency was found in 22 arteriograms and its incidence was 22% (CTimage:2); group C frequency was observed in 19 arteriograms and its incidence was 19% (CTimage:3); group D was found in 2 arteriograms and its incidence was 2% (CTimage:4) and group E was found in two arteriograms and its incidence was 2% (CTimage:5) (table 7) (graph 9).

In the CT angiographic images, group A was found to be the most prominent group. Group B was recorded as the second prominent group. The rarest group noted in this study was group E.

Among the 100 CT pelvic arteriogram images, 89 were male and 11 were female. The incidence of different groups of internal iliac artery among male and female arteriograms were studied and analysed.

Group	Frequency	Percentage
A	48	53.9%
B	22	24.7%
C	16	18.0%
D	2	2.2%
E	1	1.1%
Total	89	100%

Table 8: Distribution of different types in the branching pattern of internal iliac artery in male adult CT angiogram

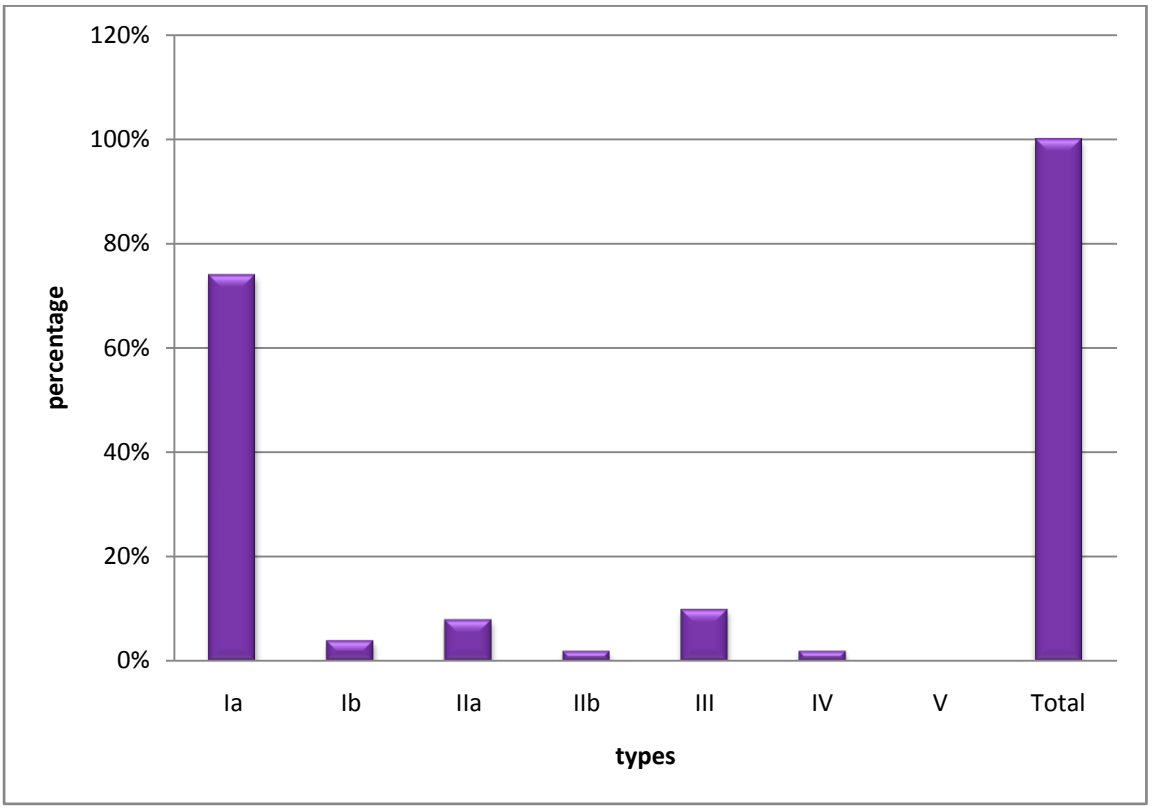
Out of 89 male CT pelvic arteriogram images, group A was found in 48 arteriograms; group B was noticed in 22 arteriograms; group C was observed in 16 arteriograms; group D was noticed in 2 arteriograms; group E was observed in 1 arteriogram. In males, group E was the rarest group (table 8) (graph 10).

Group	Frequency	Percentage
A	7	63.6%
B	0	0.0%
C	3	27.3%
D	0	0.0%
E	1	9.1%
Total	11	100%

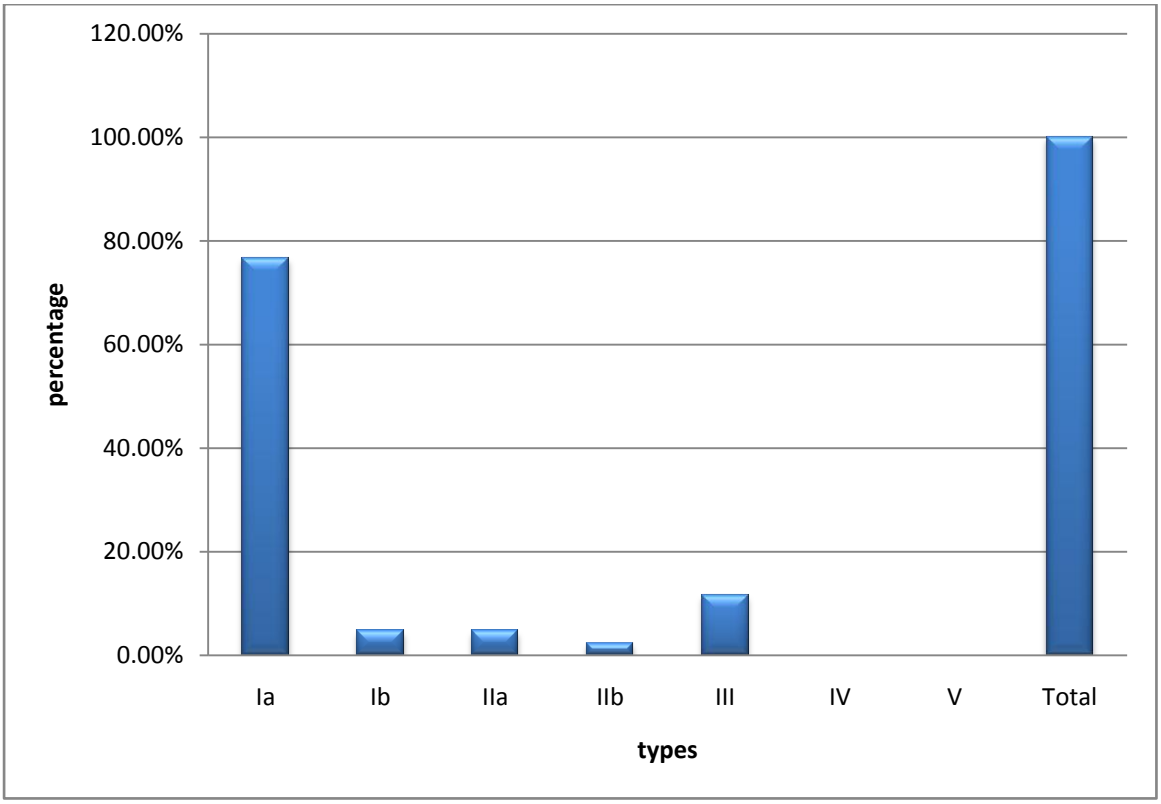
Table 9: Distribution of different types in the branching pattern of internal iliac artery in female adult CT angiogram

Out of 11 female CT pelvic arteriogram images, group A was found in 7 arteriograms; group C was observed in 3 arteriograms; group E was noticed in 1 arteriogram. Among the female internal iliac artery arteriographic images, group B and D were not noticed (table 9) (graph11).

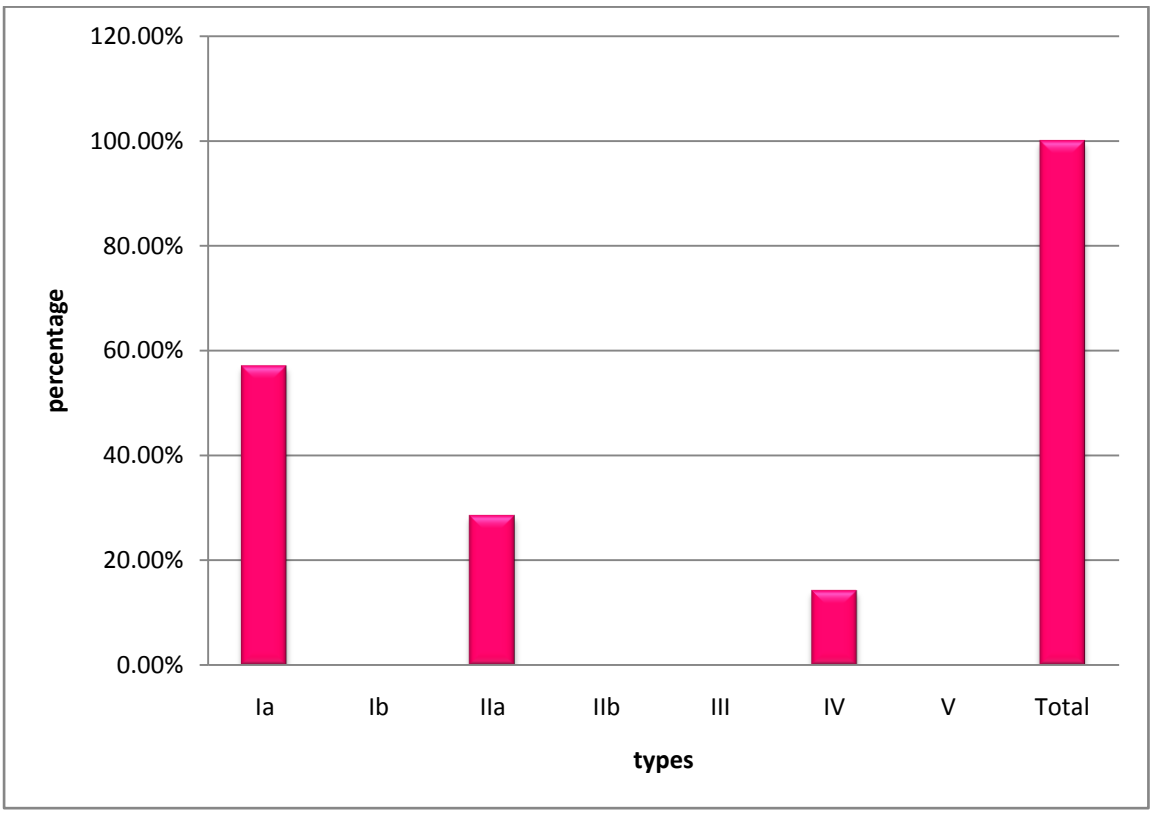
The frequency of male and female adult CT pelvic angiogram images were compared and analysed. In that, the group A was found to be the most prominent group in females (63.6%) and the group D and E were noted as the rarest groups and noted only in males. Group B was seen only in males and incidence was 24.7%. Group C was observed predominantly in females (27.3%) (graph12).



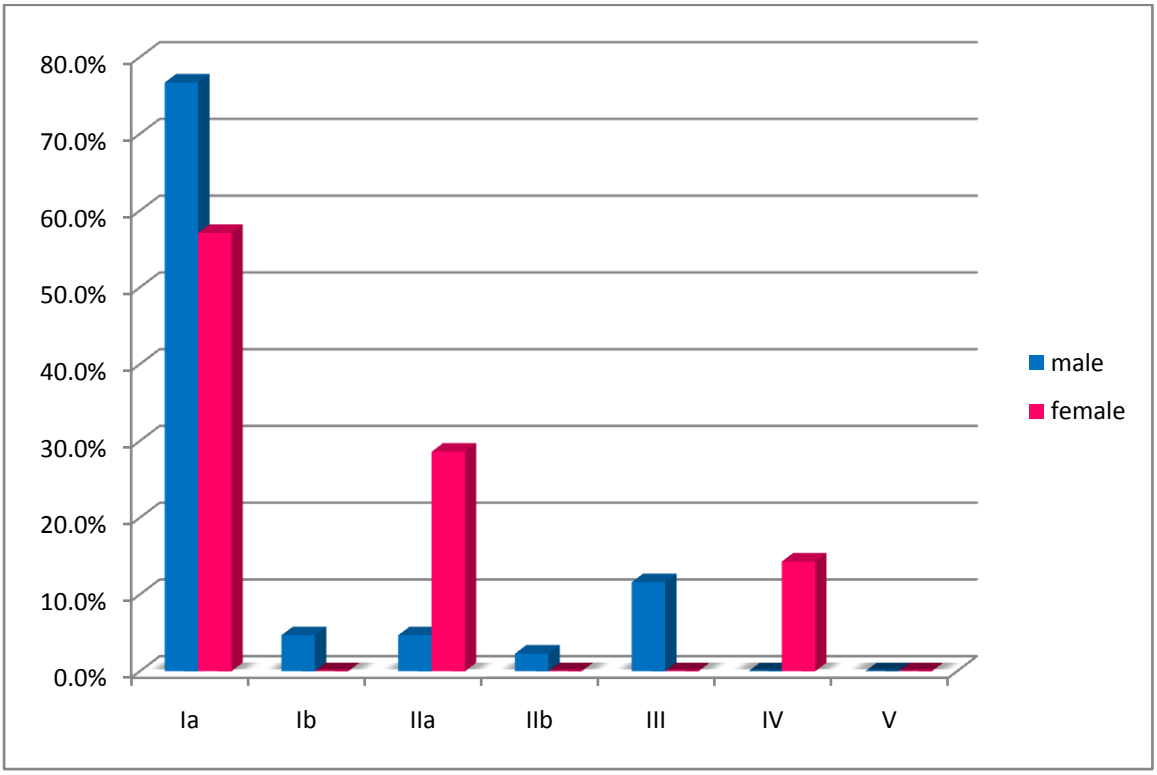
Graph 1: Distribution of different types in the branching pattern of internal iliac artery in adult wet pelvic specimens



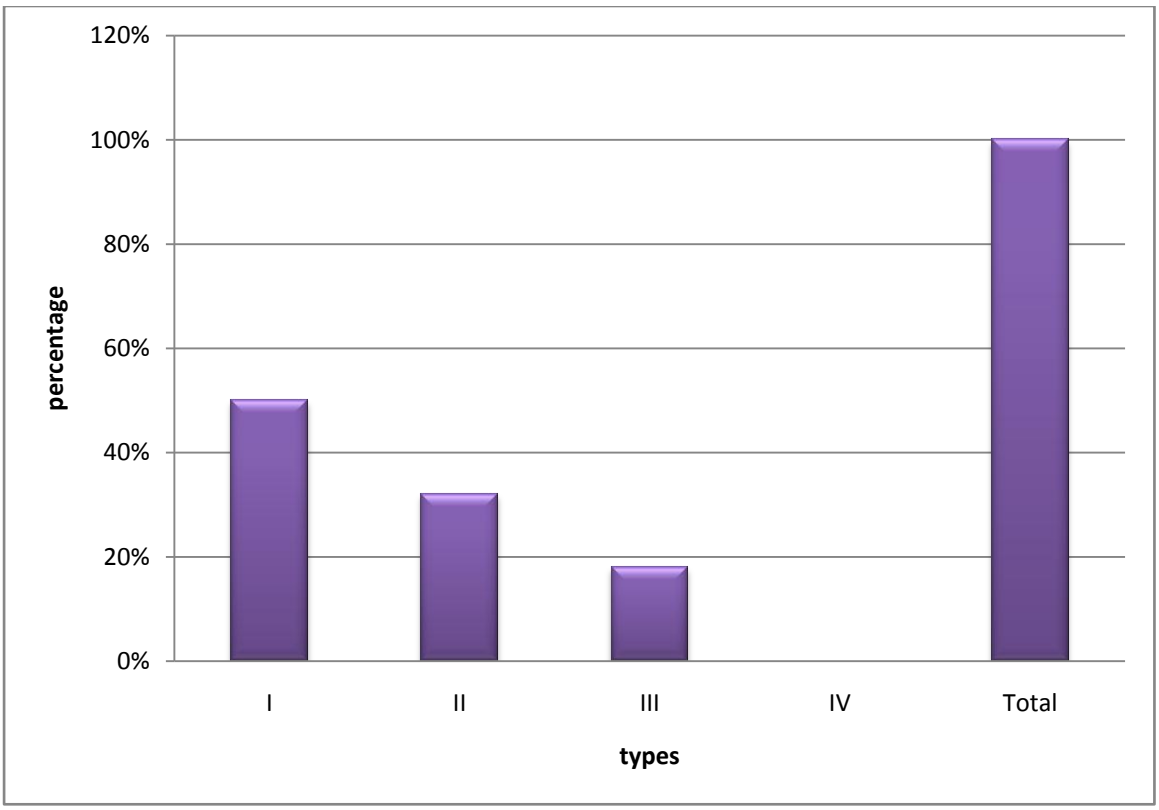
Graph 2: Distribution of different types in the branching pattern of internal iliac artery in male adult wet pelvic specimens



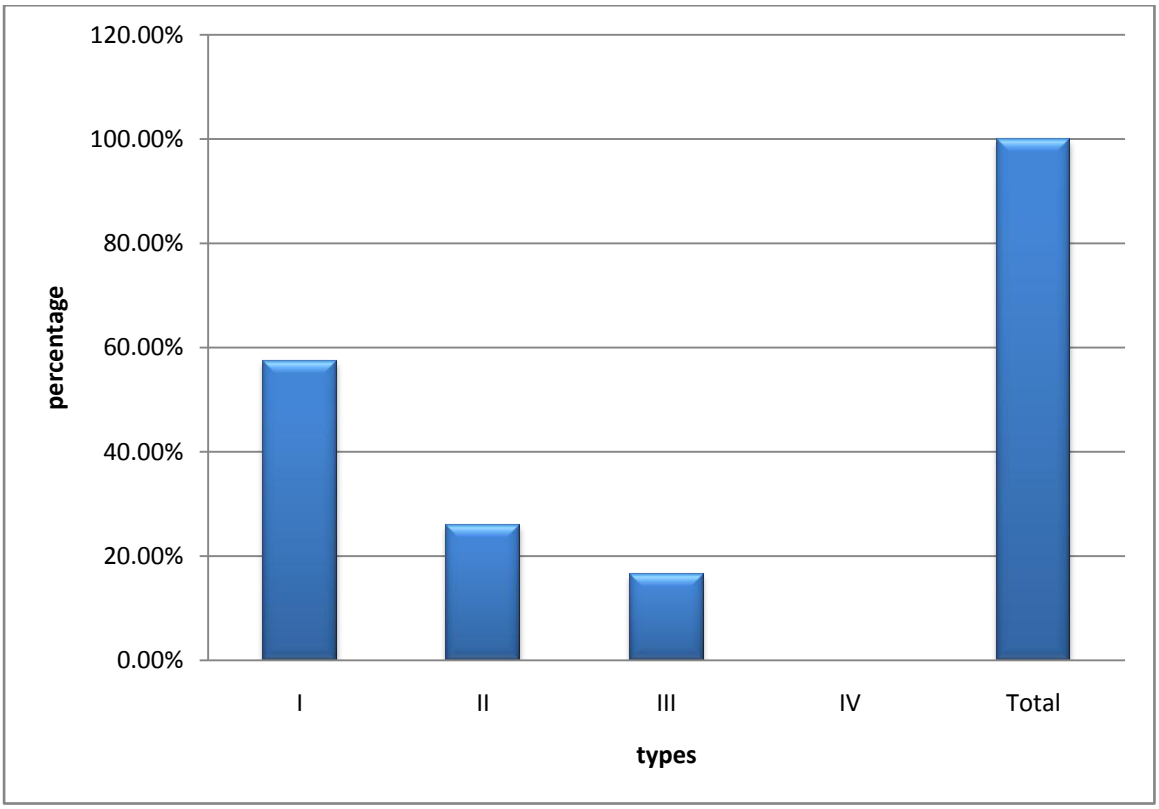
Graph 3: Distribution of different types in the branching pattern of internal iliac artery in female adult wet pelvic specimens



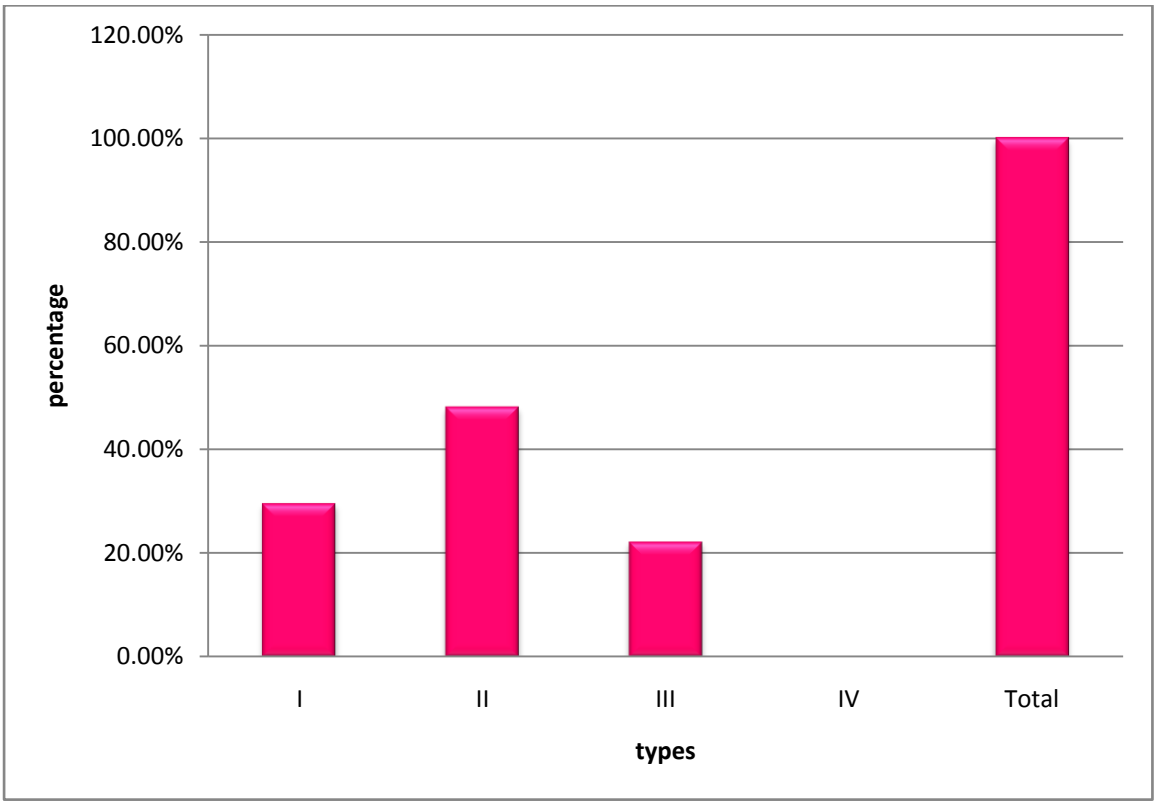
Graph 4: Comparing the distribution of different types in the branching pattern of internal iliac artery in male and female adult wet pelvic specimens



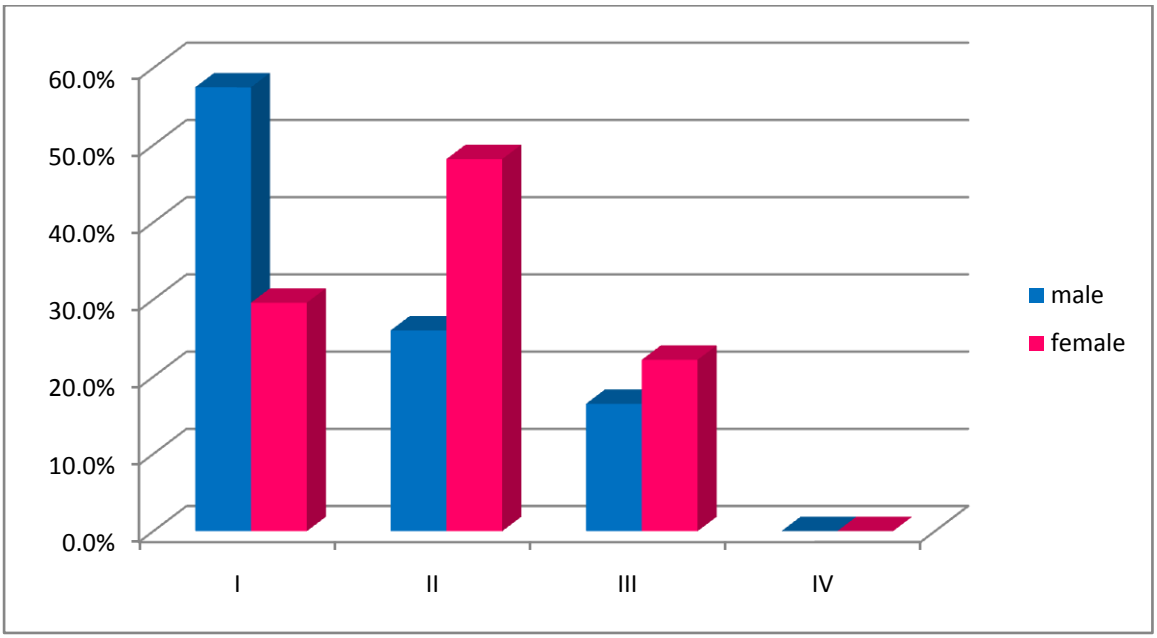
Graph 5: Distribution of different types in the branching pattern of internal iliac artery in spontaneously aborted foetal specimens



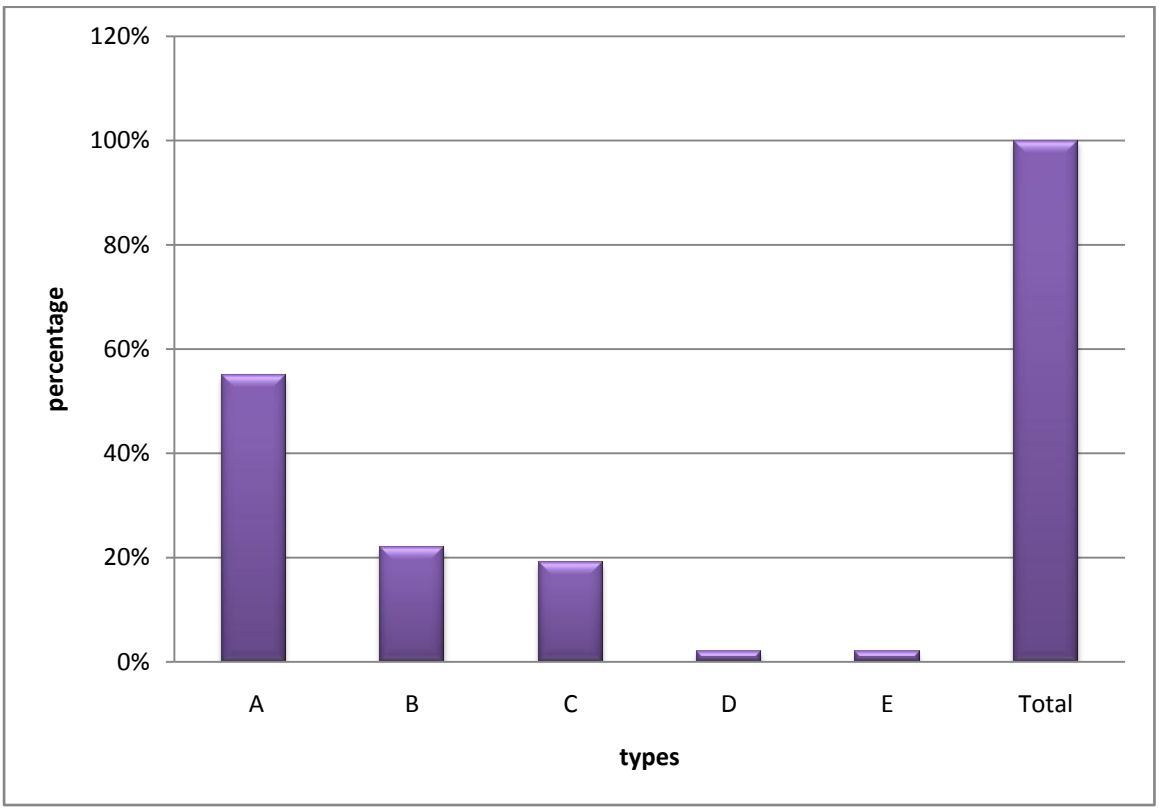
Graph 6: Distribution of different types in the branching pattern of internal iliac artery in spontaneously aborted male foetal specimens



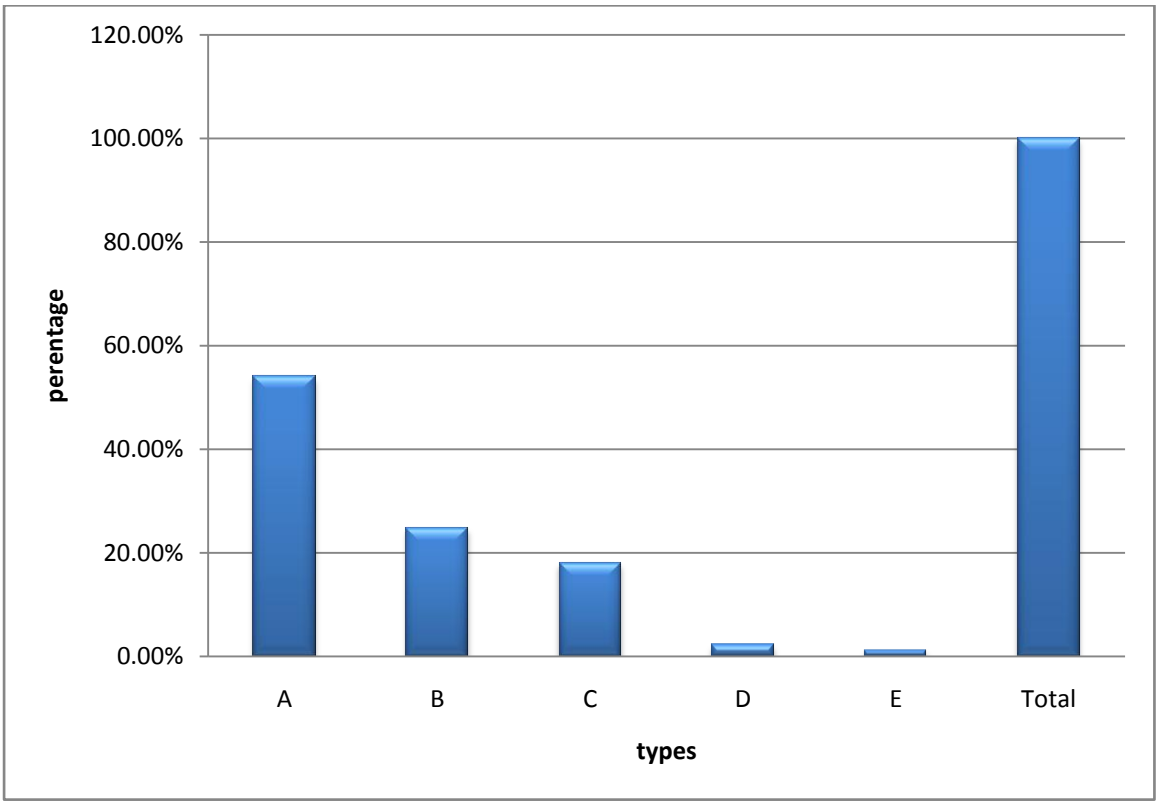
Graph 7: Distribution of different types in the branching pattern of internal iliac artery in spontaneously aborted female foetal specimens



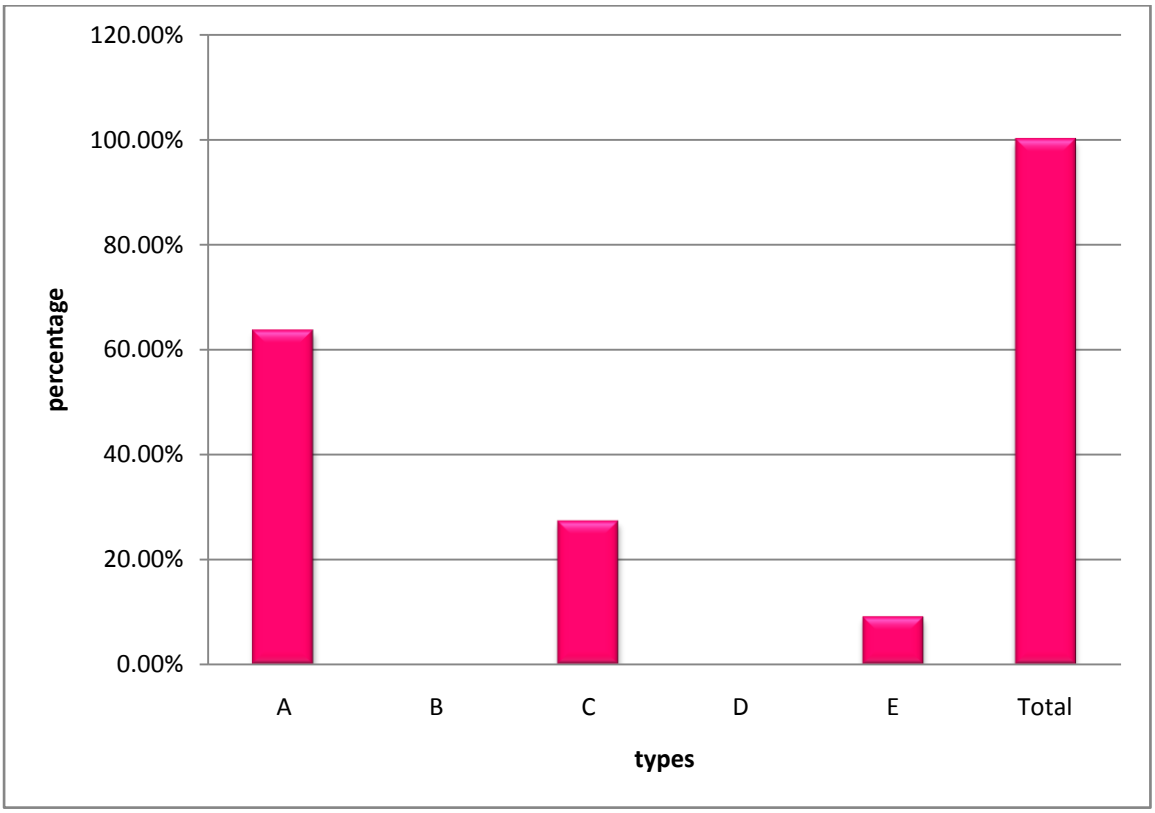
Graph 8: Comparing the distribution of different types in the branching pattern of internal iliac artery in spontaneously aborted male and female foetal specimens



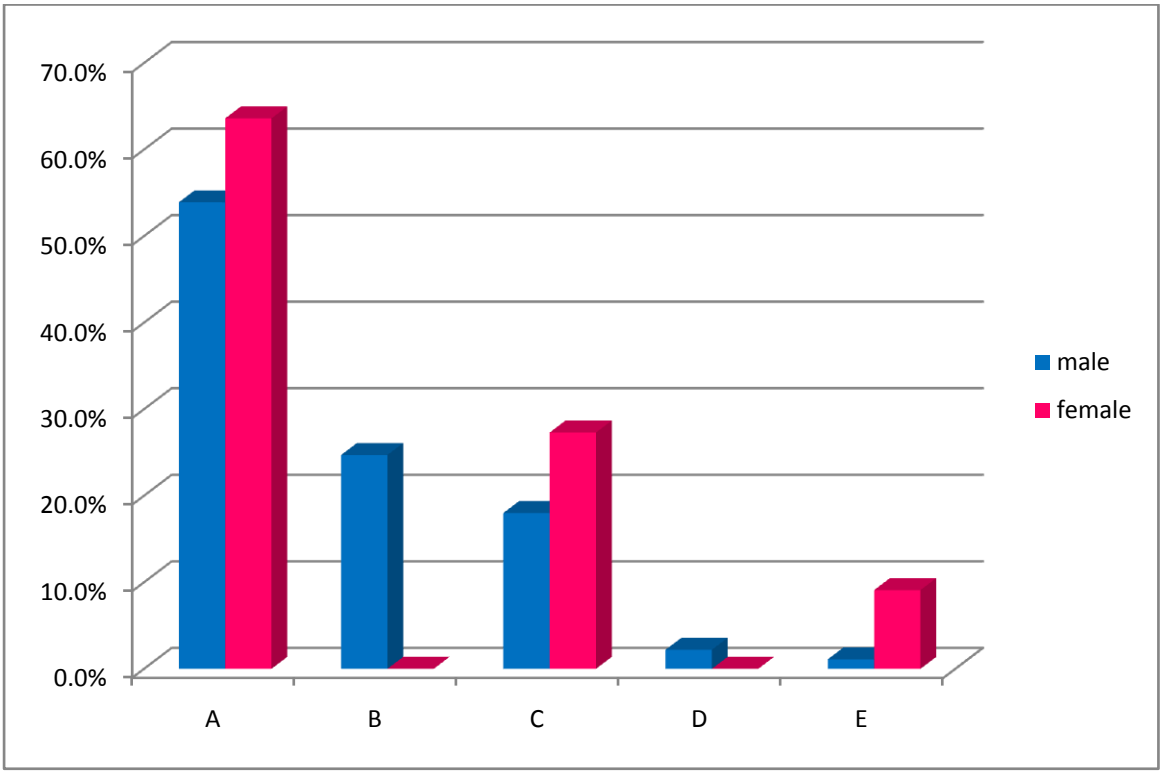
Graph 9: Distribution of different types in the branching pattern of internal iliac artery in adult CT angiogram



Graph 10: Distribution of different types in the branching pattern of internal iliac artery in adult male CT angiogram



Graph 11: Distribution of different types in the branching pattern of internal iliac artery in adult female CT angiogram



Graph 12: Comparing the distribution of different types in the branching pattern of internal iliac artery in adult male and female CT angiogram

IMAGES: ADULT WET CADAVERIC SPECIMENS

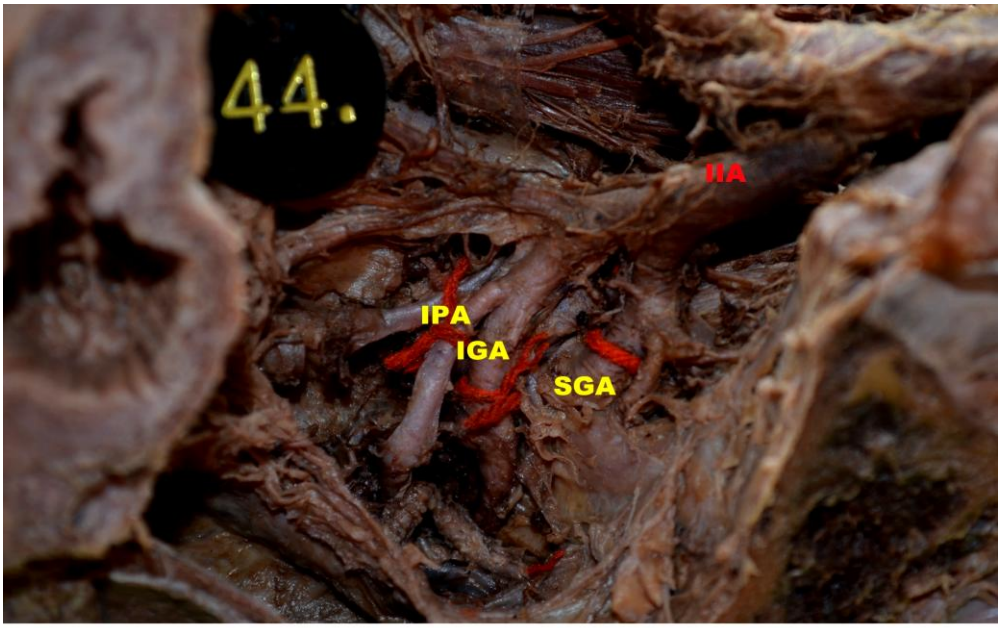


Fig1: Inferior gluteal artery (IGA) and internal pudendal artery (IPA) took origin from a common trunk; but superior gluteal artery (SGA) took origin independently. inside the pelvis - type Ia

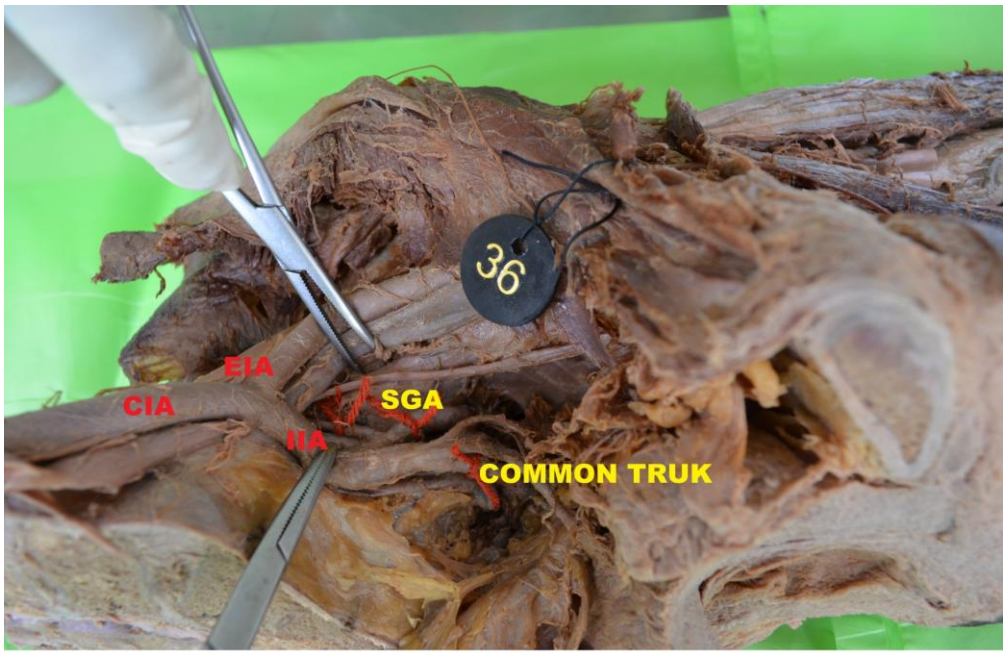


Fig 2: Superior gluteal artery (SGA) took origin independently; but inferior gluteal (IGA) and internal pudendal artery (IPA) took origin from a shared trunk which was divided outside the pelvis. - type Ib

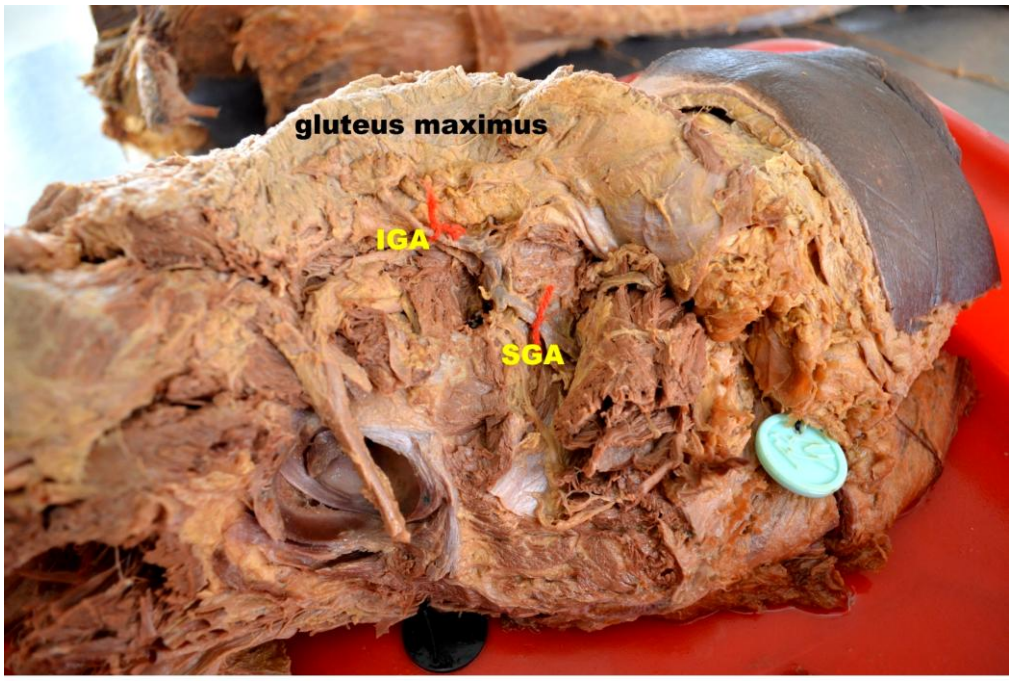


Fig3: shows the divided artery from the common trunk which was noted outside the pelvic cavity - type Ib.

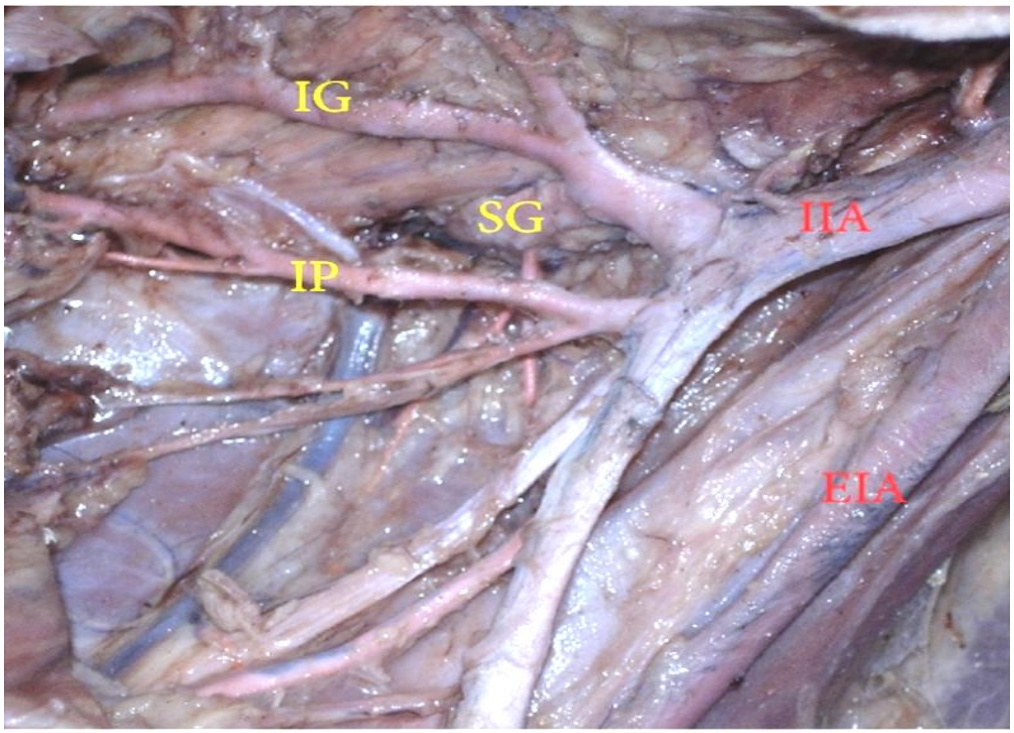


Fig 4: shows the origin of superior and inferior gluteal arteries (SGA, IGA)were arising from a common trunk; but internal pudendal artery (IPA) took origin independently ; was noted inside the pelvis - type IIa

Fig5: shows the independent origin of internal pudendal artery (IPA) and noted a common trunk of superior and inferior gluteal arteries (SGA, IGA)- type IIb.

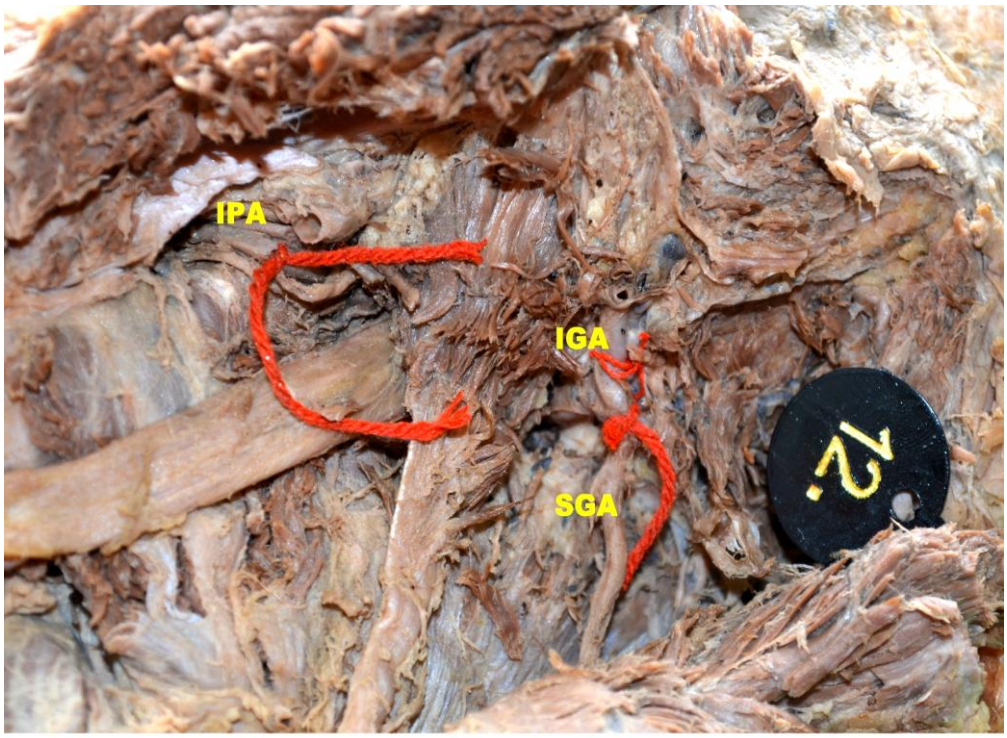


Fig 6: shows the divided superior and inferior gluteal arteries (SGA, IGA) were seen outside the pelvis - type IIb

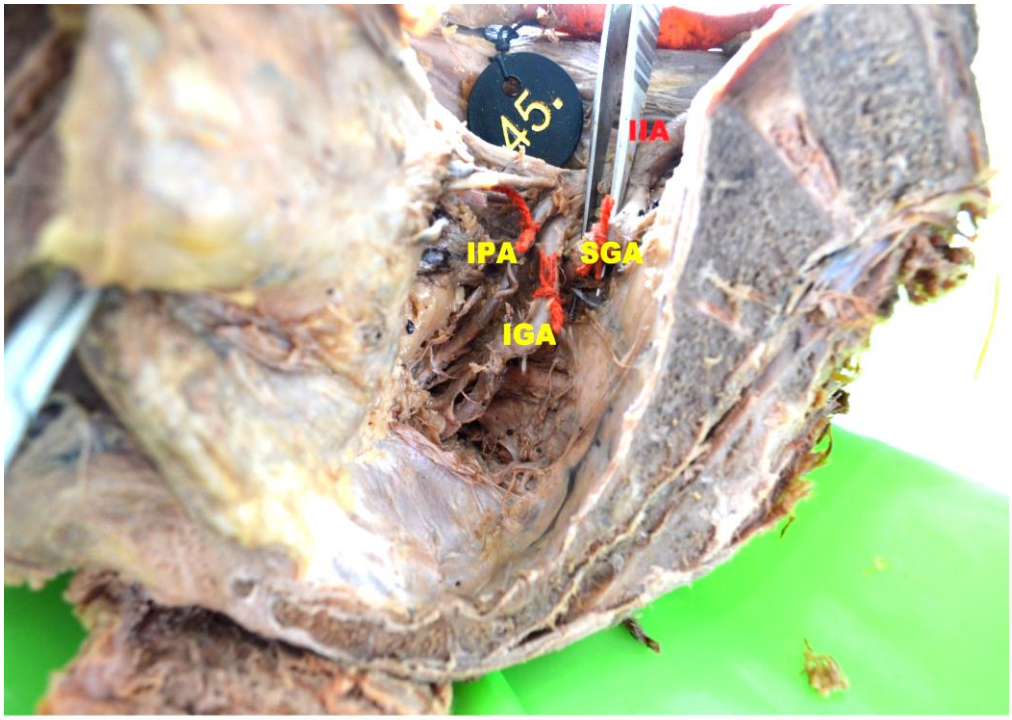


Fig 7: superior gluteal (SGA), inferior gluteal (IGA) and internal pudendal (IPA) arteries had took origin independently- type III

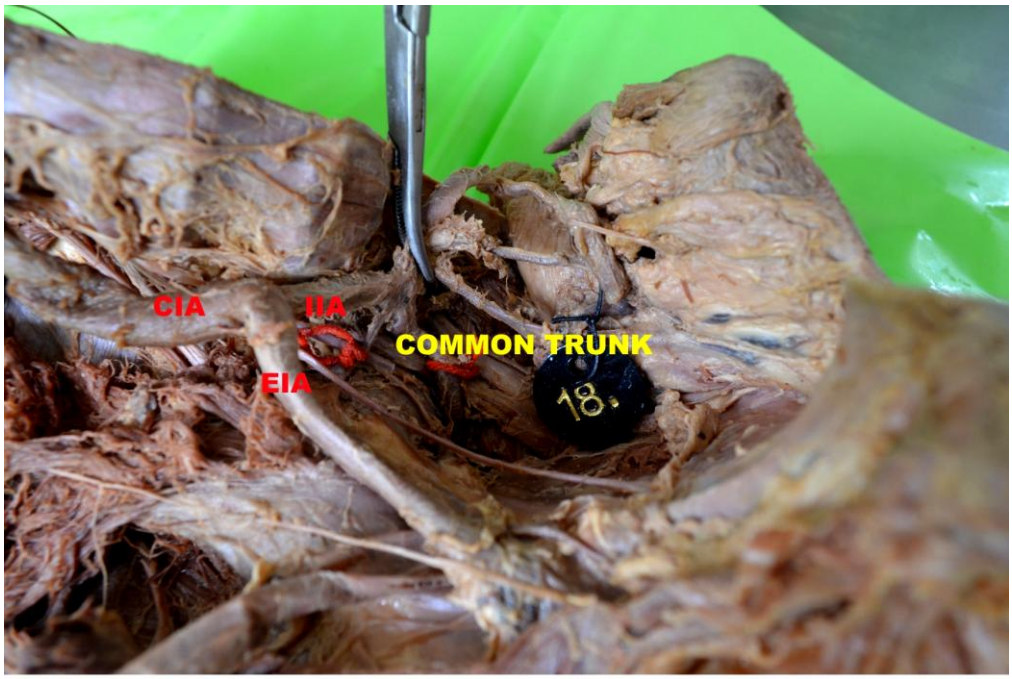


Fig 8: a common trunk was noted inside the pelvis - type IV

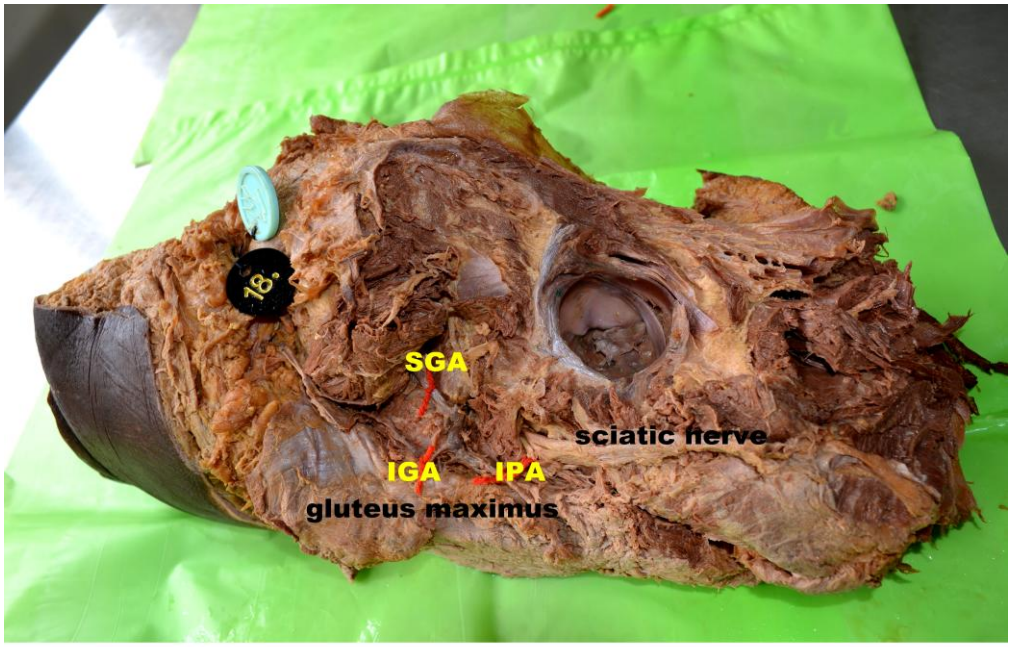


Fig 9: superior gluteal artery (SGA), inferior gluteal artery (IGA), internal pudendal artery (IPA) took origin from the common trunk dividing outside the pelvis - type IV

IMAGES: ABORTED FOETAL SPECIMENS:

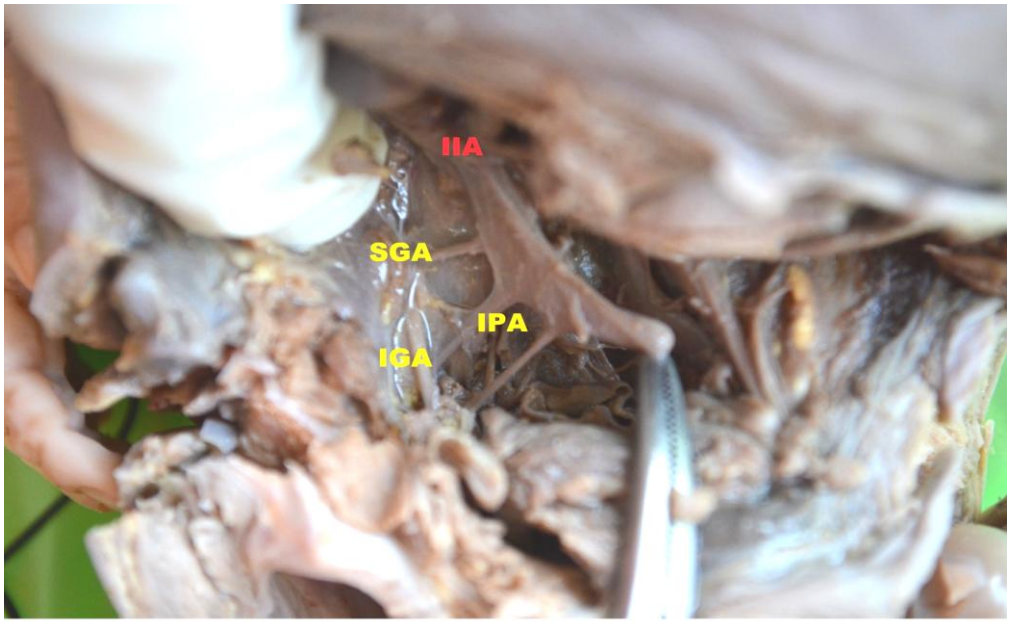


Fig 10: shows the origin of superior gluteal artery (SGA) independently and the inferior gluteal (IGA) and internal pudendal (IPA) arteries took origin from a shared stem - type I

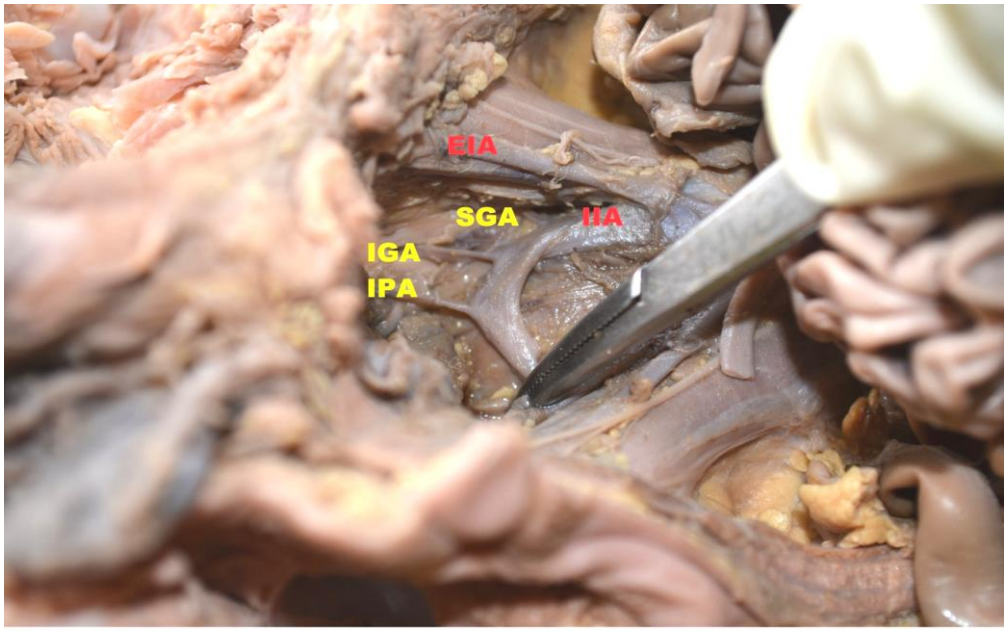


Fig 11: superior gluteal (SGA), inferior gluteal (IGA) and internal pudendal (IPA) arteries took origin independently from each other- type II

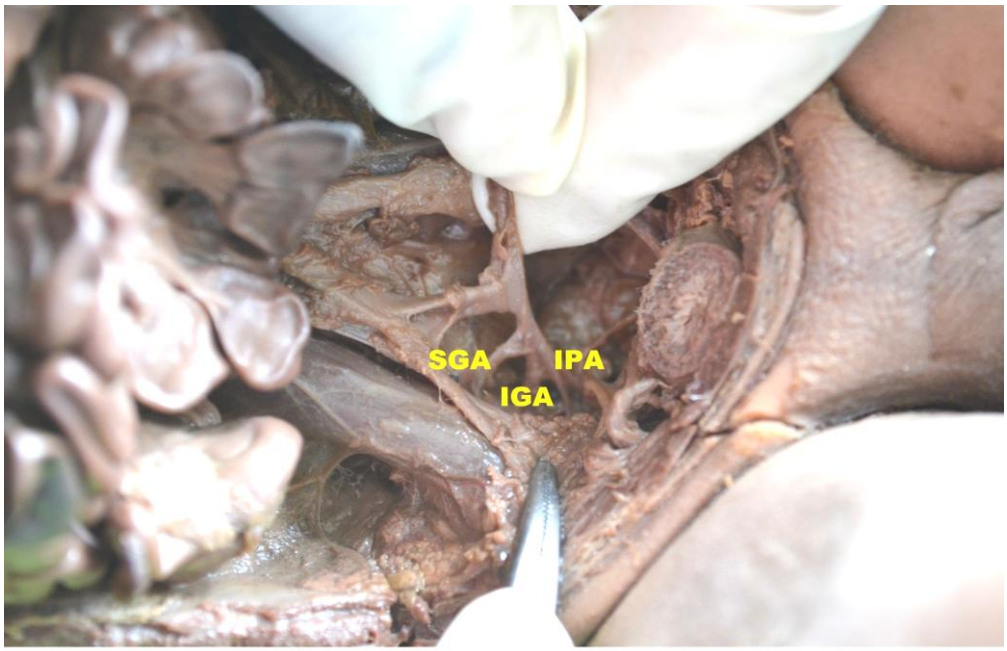
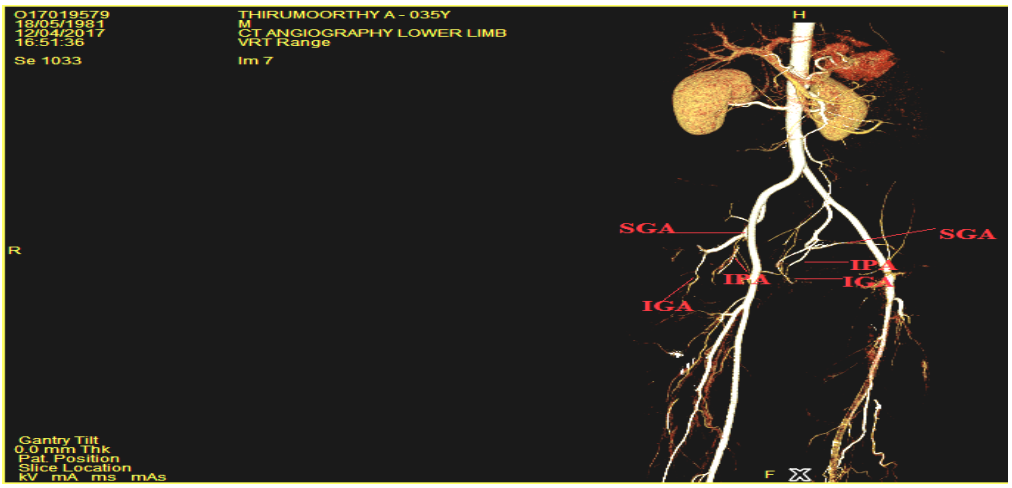
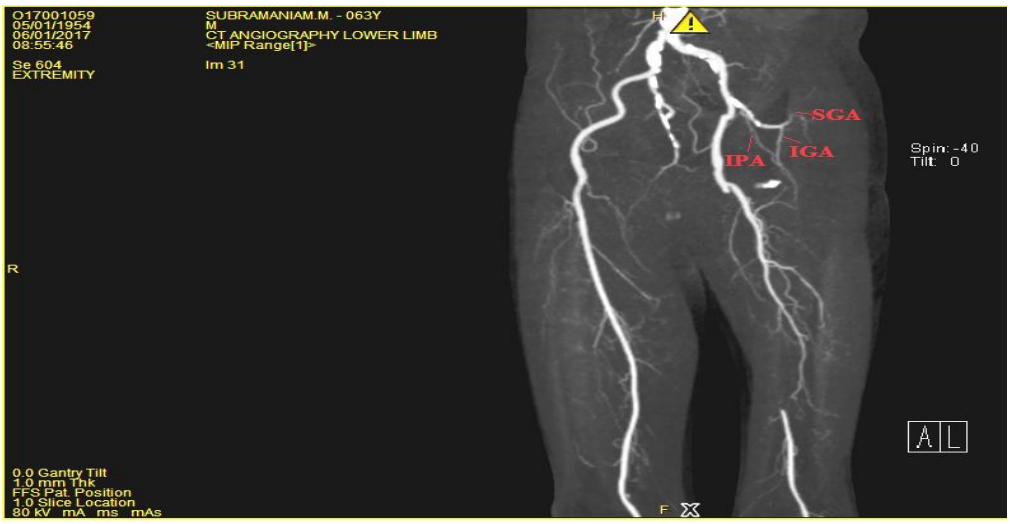


Fig 12: superior (SGA) and inferior (IGA) gluteal arteries took origin from a shared trunk; but the internal pudendal artery (IPA) gave origin independently- type III

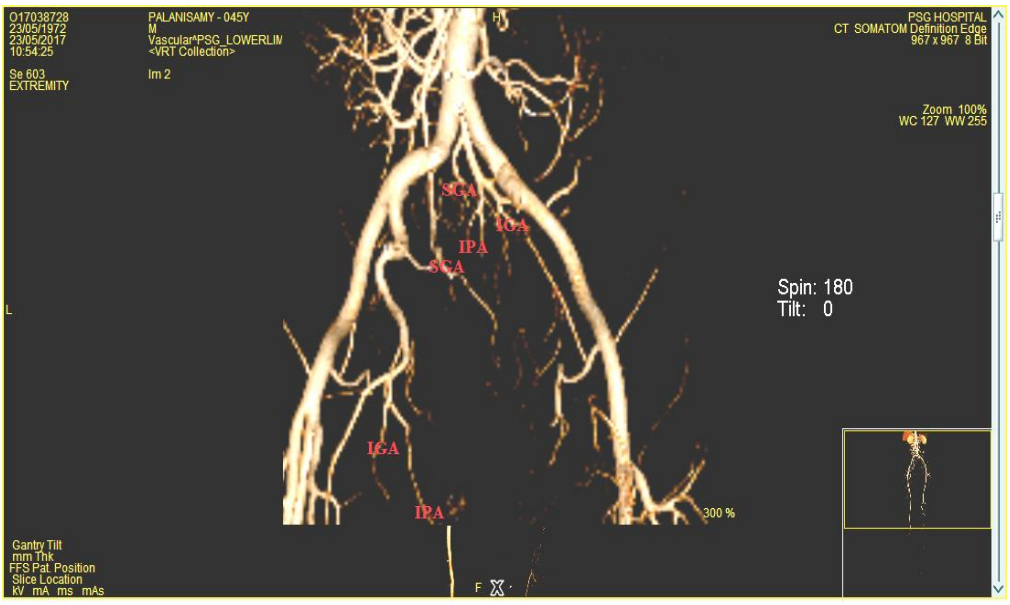
IMAGES: CT ANGIOGRAM



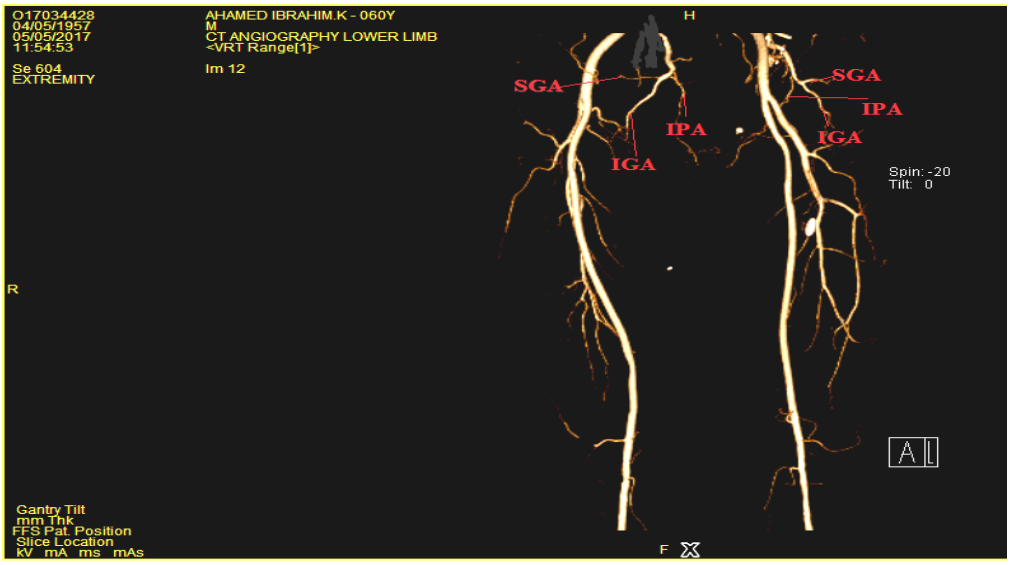
CT image 1: Left side shows internal pudendal (IPA) and inferior gluteal (IGA) arteries took origin from a common stem whereas the superior gluteal artery (SGA) had an independent origin - type A



CT image 2: shows superior (SGA) and inferior (IGA) gluteal arteries took origin from a common stem whereas the internal pudendal artery (IPA) had an independent origin - type B



CT image 3: Right side shows the origin of superior gluteal, inferior gluteal and internal pudendal arteries were independent of each other - type C



CT image 4: Right side shows the origin of superior gluteal (SGA), inferior gluteal (IGA)and internal pudendal (IPA) arteries came from a shared trunk - type D

CT image 5: shows the origin of internal pudendal (IPA) and superior gluteal (SGA) arteries shared a common stem but the inferior gluteal artery (IGA) came from the different branch of internal iliac artery- type E

DISCUSSION

The morphological variations in the three large branches of the internal iliac artery were studied in 50 adult wet pelvic specimens from the department of anatomy; 100 spontaneously aborted foetal specimens from the department of obstetrics and gynaecology and 100 CT pelvic arteriogram images of normal individuals from the department of radiology. The findings were recorded, analysed and compared with the studies of other authors and discussed separately as follows.

a) ADULT WET PELVIC SPECIMENS:

The different types in the branching pattern of internal iliac artery in adult wet pelvic specimens were compared with the previous studies.

In the present study, the type Ia branching pattern of the internal iliac artery was found in 74% of the specimens and was noted as the most prominent type. The findings of the above study was correlated with the study done by Yamaki (1998)[76] who reported that 58% of the specimens belonged to this type and was considered to be the most common type among the Japanese population. The study conducted by Sumathilatha Sakthivelavan (2014) [62], showed that 60.6% of the specimens belonged to type Ia. She had reported type Ia as the most common type among the Indian population.

The results of the above study was supported by Ramakrishnan PK's [55] (2012) study which showed that 26% of the specimens belonged to the type Ia and considered as the most common type among the south Indian population.

Type Ia arrangement was noted in 68% of specimens in the study carried out by Savitha kumari [37] (2016) which was in coherence with the present study (graph13).

The findings of the present study was also paralleled with the studies done by Nataraj KM [45] and Senthamizh chelvan [64] (2017) who noticed the type Ia branching pattern of the internal iliac artery in 52% and 56% of the specimens respectively (table10).

Author	Percentage
Yamaki	58%
Sumathilatha sakthivelavan	60.06%
Ramakrishnan PK	26%
Savitha kumara	68%
Nataraj KM	52%
Senthamizhchelvan	56%
Present study	74%

Table 10: Comparing the type Ia distribution in the branching pattern of internal iliac artery in adult pelvic specimens among various authors

In the present study, the type Ib branching pattern of the internal iliac artery was found in 4% of the specimens. The findings of the above study was correlated with the study done by Sumathilatha Sakthivelavan [62] (2014), who noted 2.6% of type Ib branching pattern in her study. The study by Ramakrishnan PK (2012) [55], observed 4% type Ib in the specimens studied. The findings of the present study was in coherence with the study done by Senthamizh chelvan [64] (2017), who reported type Ib branching pattern of the internal iliac artery in 12% of the specimens (graph14).

The type Ib arrangement in the branching pattern of the adult internal iliac artery was not reported in the studies done by Nataraj KM (2017) [45] and Savitha kumari (2016) [37], which shows that type Ib is not a common pattern (table 11).

Author	Percentage
Sumathilatha sakthivelavan	2.60%
Ramakrishnan PK	4%
Senthamizhchelvan	12%
Present study	4%

Table 11: Comparing the type Ib distribution in the branching pattern of internal iliac artery in adult pelvic specimens among various authors

In the present study, the type IIa branching pattern of the internal iliac artery was found in 8% of the specimens. The results of the above study on the type IIa arrangement is supported by Sumathilatha Sakthivelavan's [62] (2014) study, which showed type IIa pattern in 15.8% of the specimens. Type IIa arrangement was observed in 4% of specimens in the study done by Ramakrishnan PK (2012) [55]. His study confirms the findings of the present study (table12) (graph15).

Author	Percentage
Sumathilatha sakthivelavan	15.80%
Ramakrishnan PK	4%
Present study	8%

Table 12: Comparing the type IIa distribution in the branching pattern of internal iliac artery in adult pelvic specimens among various authors

In the current study, the type IIb arrangement in the branching pattern of the internal iliac artery was found in 2% of the specimens. This study was not seen in some studies which were done by Sumathilatha Sakthivelavan (2014) [62] and Ramakrishnan PK (2012) [55]. The uncategorized type II arrangement was seen in some studies which were done by Nataraj KM (2017) [45], Senthamizh chelvan (2017) [64] and Savitha kumari (2016) [37]. Hence, these studies were not paralleled with the present study.

In the present study, the type III arrangement in the branching pattern of the internal iliac artery was found in 10% of the specimens and was noted as the second most dominant type. The findings of the above study was correlated with the study done by Yamaki [76] (1998) who observed this type in 22.8% of the specimens. Yamaki also considered this type as the second most prominent type. The study conducted by Sumathilatha Sakthivelavan [61](2014), reported that 21% of the specimens belonged to this type and considered it as the second most common type among the Indian population.

Authors like Ramakrishnan PK (2012) [55], Nataraj KM (2017) [45], Senthamizh chelvan (2017) [64] and Savitha kumari (2016) [37] conducted studies which were in coherence with the present study. In their studies, type III branching pattern of the internal iliac artery, was noted in 15%, 16%, 43% and 20% of specimens respectively (table 13) (graph 16).

Author	Percentage
Yamaki	22.80%
Sumathilatha sakthivelavan	21%
Ramakrishnan PK	15%
Savitha kumara	20%
Nataraj KM	16%
Senthamizhchelvan	43%
Present study	10%

Table 13: Comparing the type III distribution in the branching pattern of internal iliac artery in adult pelvic specimens among various authors

In the present study, the type IV arrangement in the branching pattern of the internal iliac artery was found in 2% of the specimens. The findings of the above study was correlated with the study done by Yamaki [76] (1998) who observed that 22.8% of the specimens belonged to this type. Studies done by Ramakrishnan PK [55] (2012), Senthamizh chelvan (2017) [64] and Savitha kumari (2016) [37] showed results which were in coherence with the present study. In the above mentioned studies, type III arrangement of the branching pattern of the internal iliac artery was noted in 1%, 4% and 6% of the specimens respectively (table 14).

The type IV arrangement was not reported in the studies done by Sumathilatha Sakthivelavan (2014) [62] and Nataraj KM (2017) [45] which shows the rarity of this branching pattern (graph17).

Author	Percentage
Yamaki	22.80%
Ramakrishnan PK	1%
Savitha kumara	6%
Senthamizhchelvan	4%
Present study	2%

Table 14: Comparing the type IV distribution in the branching pattern of internal iliac artery in adult pelvic specimens among various authors

In the present study, the type V branching pattern of the internal iliac artery was not seen in any of the specimens. The findings of the present study was correlated with the studies done by Sumathilatha Sakthivelavan (2014) [62], Ramakrishnan PK (2012) [55], Senthamizh chelvan (2017) [64] and Savitha kumari (2016) [37]. Nataraj KM (2017) [45] and Yamaki (1998) [76] reported type V branching pattern only in 2% and 0.2% of the specimens respectively.

According to the present study, type I was observed as the most common type among both the sexes. Authors like Rajlakshmi C [54] and Fatu (2006) [20] observed type I branching pattern of the internal iliac artery in males and type IV and V branching patterns in females.

b) SPONTANEOUSLY ABORTED FOETAL SPECIMENS:

The different types in the branching pattern of the internal iliac artery in spontaneously aborted foetal specimens were compared with the previous studies.

In the present study, the type I branching pattern of the internal iliac artery was found in 50% of the specimens and noted as the most prominent type. The findings of the above study was correlated with the study done by Hoshiai (1938) [29], who observed this type in 55.1% of the specimens and reported this type as the most common type (table15) (graph18).

The study conducted by Sumathilatha Sakthivelavan (2010) [61], confirmed type I as the most common type. According to the author Morita (1974) [42], type I branching pattern was the most prominent type and reported it in 49.1% of the specimens (table15) (graph18).

Author	Percentage
Hoshiai	55.10%
Morita	49.10%
Present study	50%

Table 15: Comparing the type I distribution in the branching pattern of internal iliac artery in spontaneously aborted foetal specimens among various authors

The type II arrangement in the branching pattern of the internal iliac artery was found in 32% of the specimens in the present study and noted as the second most prominent type. The findings of the above study was correlated with the study done by Morita [42] (1974) and observed that 22.5% of the specimens belonged to this type which was considered to be the second most common type. According to the author Hoshai (1938), the arrangement of type II was found in 16.1% of the specimens. The study conducted by Sumathilatha Sakthivelavan (2010) [61], observed that the type II was the least common among all the types (table 16) (graph19).

Author	Percentage
Hoshiai	16.10%
Morita	22.50%
Present study	32%

Table 16: Comparing the type II distribution in the branching pattern of internal iliac artery in spontaneously aborted foetal specimens among various authors

The type III arrangement was observed in 18% of the specimens in the present study. The findings of the above study was correlated with the study done by Morita (1974) [42], who observed this type in 21.7% of the specimens. According to the author Hoshiai (1938) [29], the type III arrangement was found in 26.1% of the specimens and noted it to be the second most prominent type ,which was found to be contradictory to the present study (table 17) (graph 20).

Author	Percentage
Hoshiai	26.10%
Morita	21.70%
Present study	18%

Table 17: Comparing the type III distribution in the branching pattern of internal iliac artery in spontaneously aborted foetal specimens among various authors

In the present study, the type IV was not seen in any of the specimens. Unlike the present study, Hoshiai (1938) [29] and Morita (1974) [42] observed

this arrangement in 2.6% and 6.7% of the specimens respectively (table 18) (graph21).

Author	Percentage
Hoshiai	2.60%
Morita	6.70%
Present study	0%

Table 18: Comparing the type IV distribution in the branching pattern of internal iliac artery in spontaneously aborted foetal specimens among various authors

c) CT PELVIC ARTERIOGRAM:

The different types in the branching pattern of the internal iliac artery in CT pelvic arteriogram of living adults were compared with the previous studies.

In the present study, the group A branching pattern of the internal iliac artery was found in 55% of the specimens and noted as the most prominent group. The findings of the present study was correlated with the study done by Tiago Bilhim (2010) [6] who observed group A branching pattern in 61.9% of the specimens which was noted to be the most common group (table 19) (graph 22).

Author	Percentage
Tiago Bilhim	61.90%
Present study	55%

Table 19: Comparing the group A distribution in the branching pattern of internal iliac artery in adult CT arteriogram images among various authors

The results of the present study showed that the group B branching pattern of the internal iliac artery was observed in 22% of the specimens and noted as the second most dominant group. The findings of the above study was correlated with the study done by Tiago bilhim (2010) [6], who observed group B branching pattern in 31% of the specimens and considered this group as the second most common group (table20) (graph 23).

Author	Percentage
Tiago Bilhim	31%
Present study	22%

Table 20: Comparing the group B distribution in the branching pattern of internal iliac artery in adult CT arteriogram images among various authors

The observations of the present study showed that the group C branching pattern of internal iliac artery was observed in 19% of the

specimens. The above study was compared with the study done by Tiago bilhim (2010) [6], who noted it in 7.1% of the specimens (table 21) (graph 24).

Author	Percentage
Tiago Bilhim	7.10%
Present study	19%

Table 21: Comparing the group C distribution in the branching pattern of internal iliac artery in adult CT arteriogram images among various authors

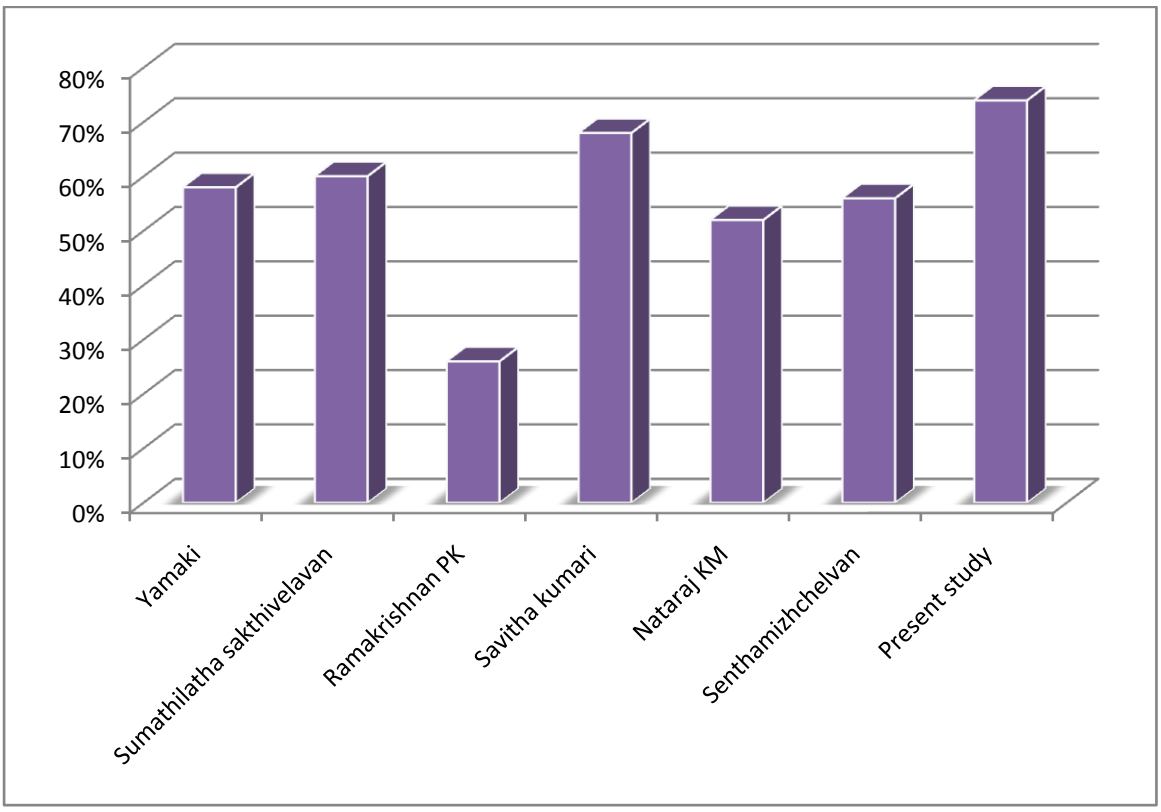
In the present study, the group D and group E in the branching pattern of the internal iliac artery were found in 2% of each of the specimens, and noted as the least common group in Yamaki classification [76] (table 22) (table23). Contradictory to the present study, the group D and group E were not found by Tiago bilhim (2010) [6], which shows that groups D and E are not very common types (graph 25) (graph 26). Hence, these groups were considered as the rare groups in the branching pattern of the internal iliac artery.

Author	Percentage
Tiago Bilhim	2%
Present study	0%

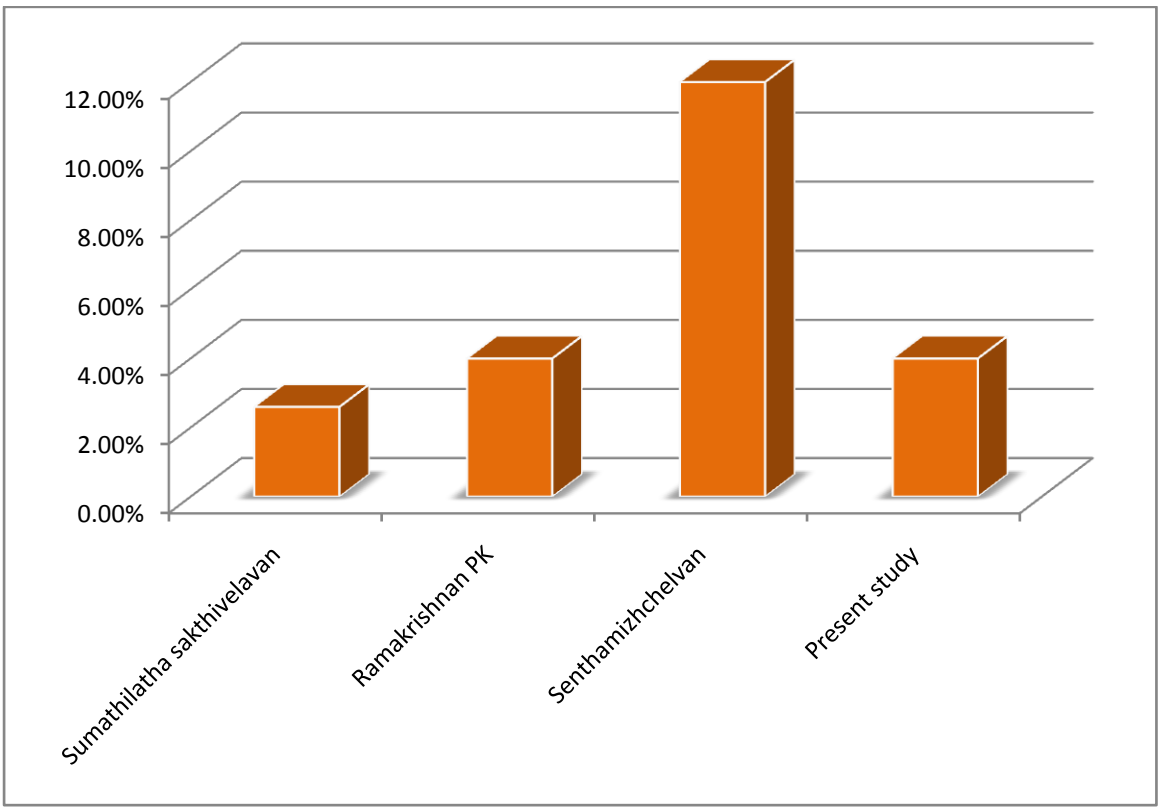
Table 22: Comparing the group D distribution in the branching pattern of internal iliac artery in adult CT arteriogram images among various authors

Author	Percentage
Tiago Bilhim	2%
Present study	0%

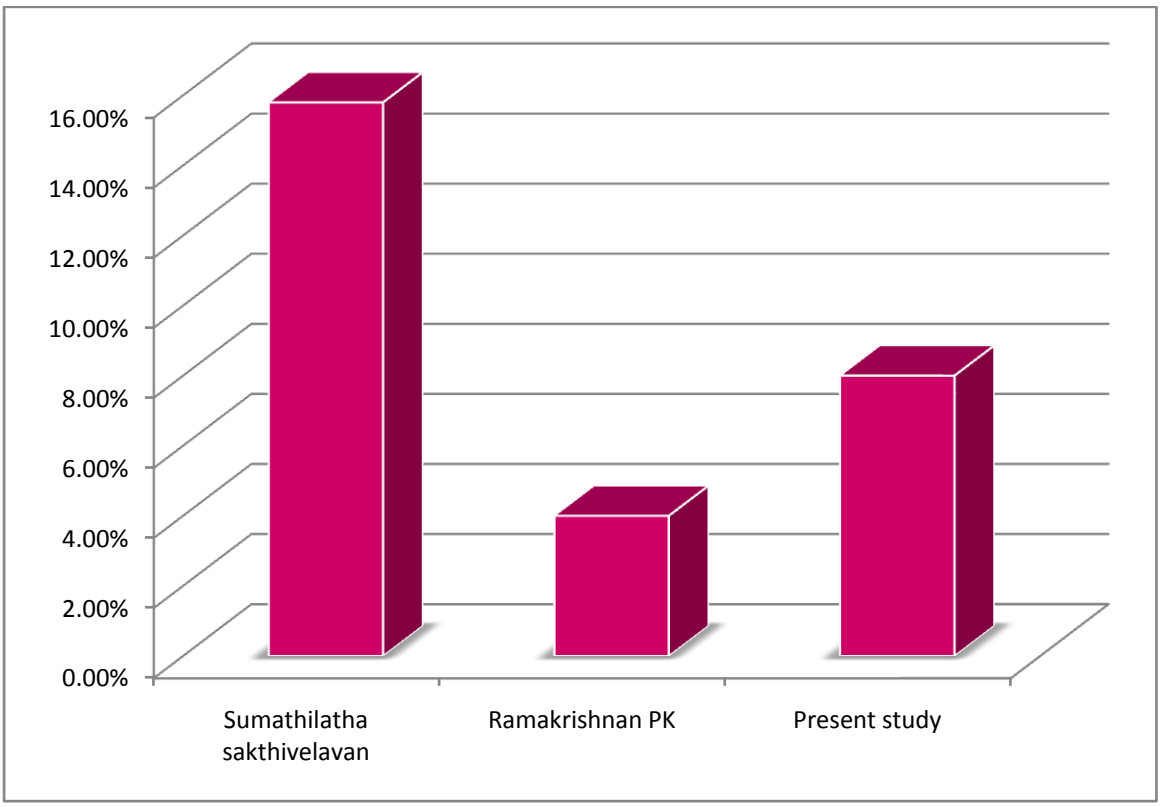
Table 23: Comparing the group E distribution in the branching pattern of internal iliac artery in adult CT arteriogram images among various authors



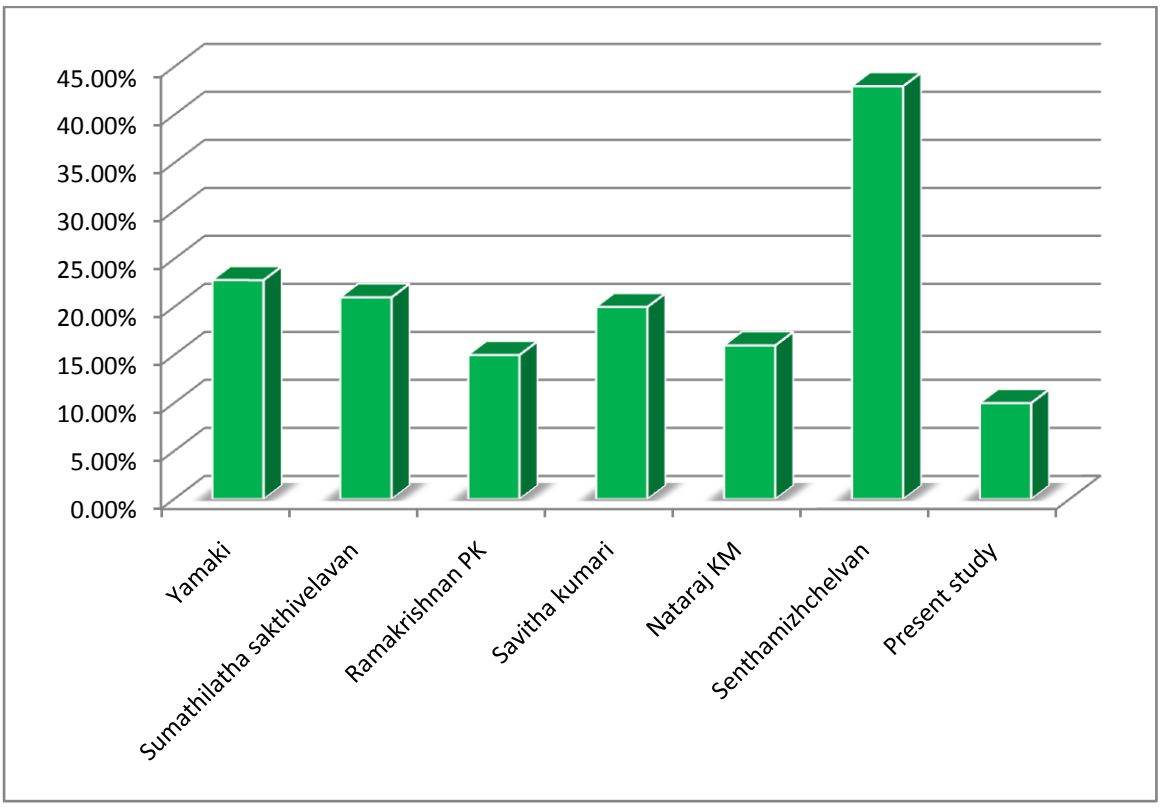
Graph 13: Comparing the type Ia of adult branching pattern among various authors in wet pelvic specimens



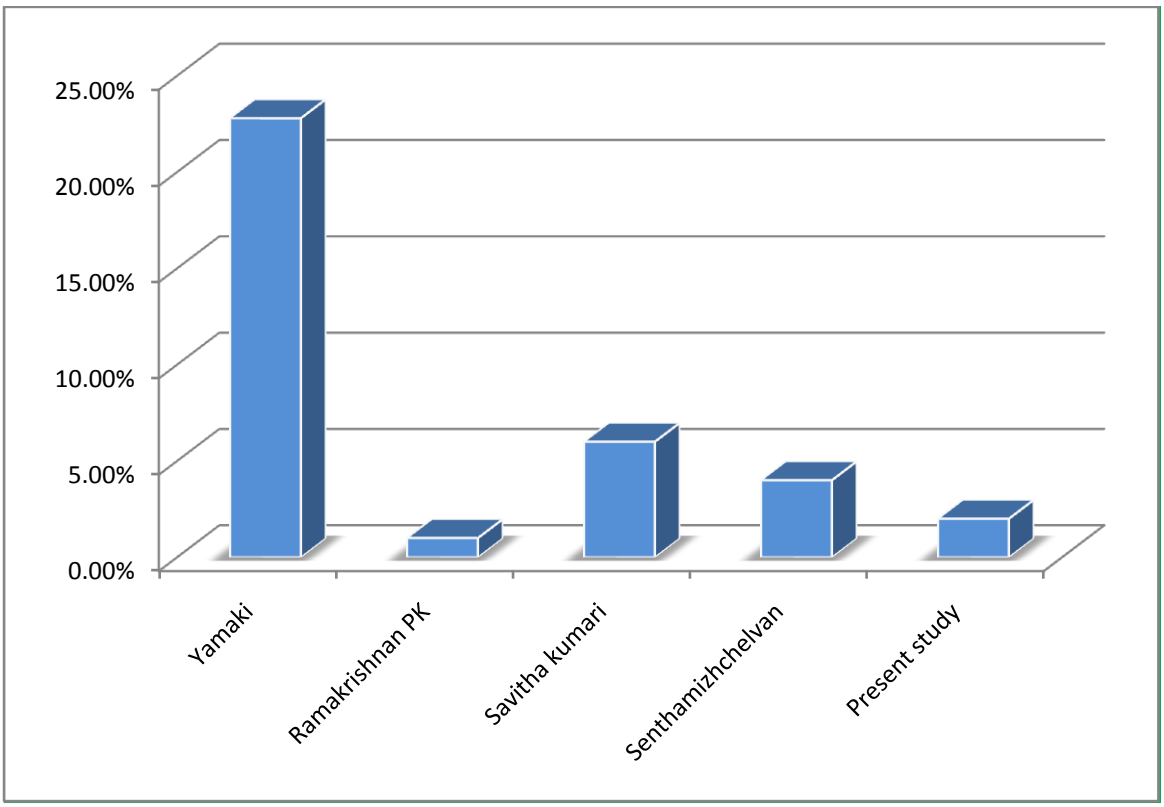
Graph 14: Comparing the type Ib of adult branching pattern among various authors in wet pelvic specimens



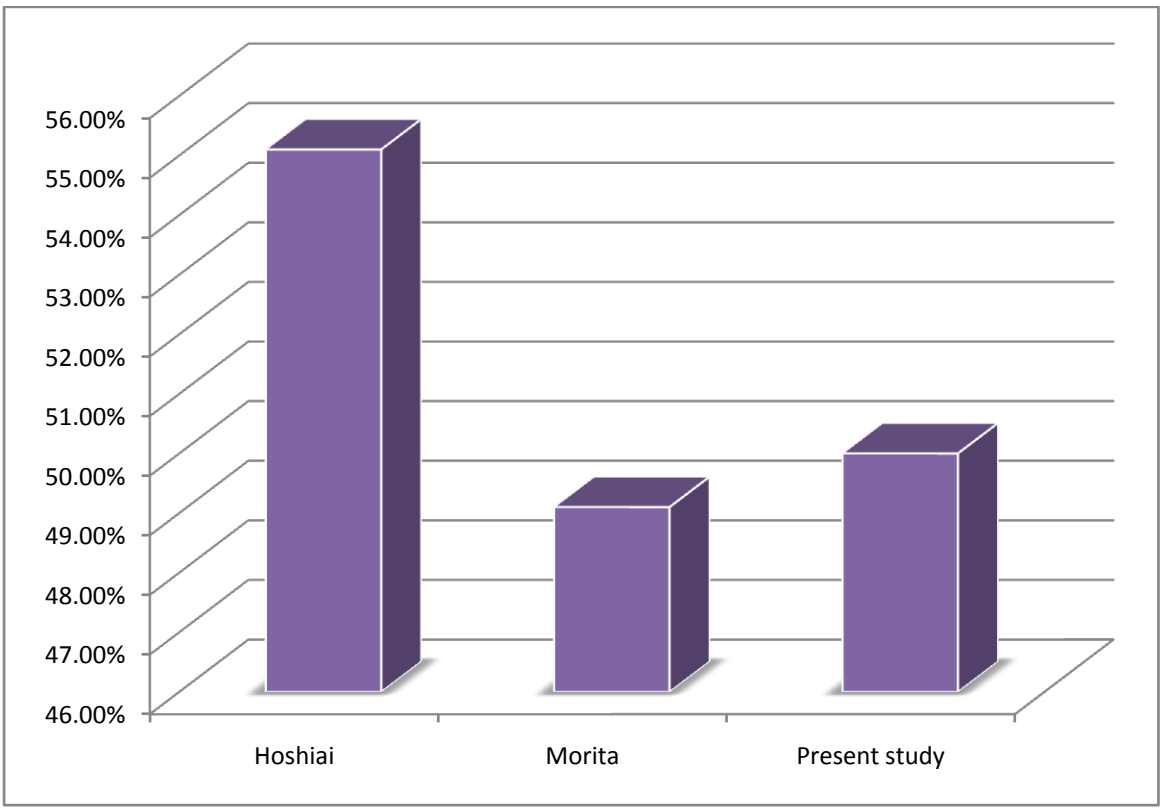
Graph 15: Comparing the type IIa of adult branching pattern among various authors in wet pelvic specimens



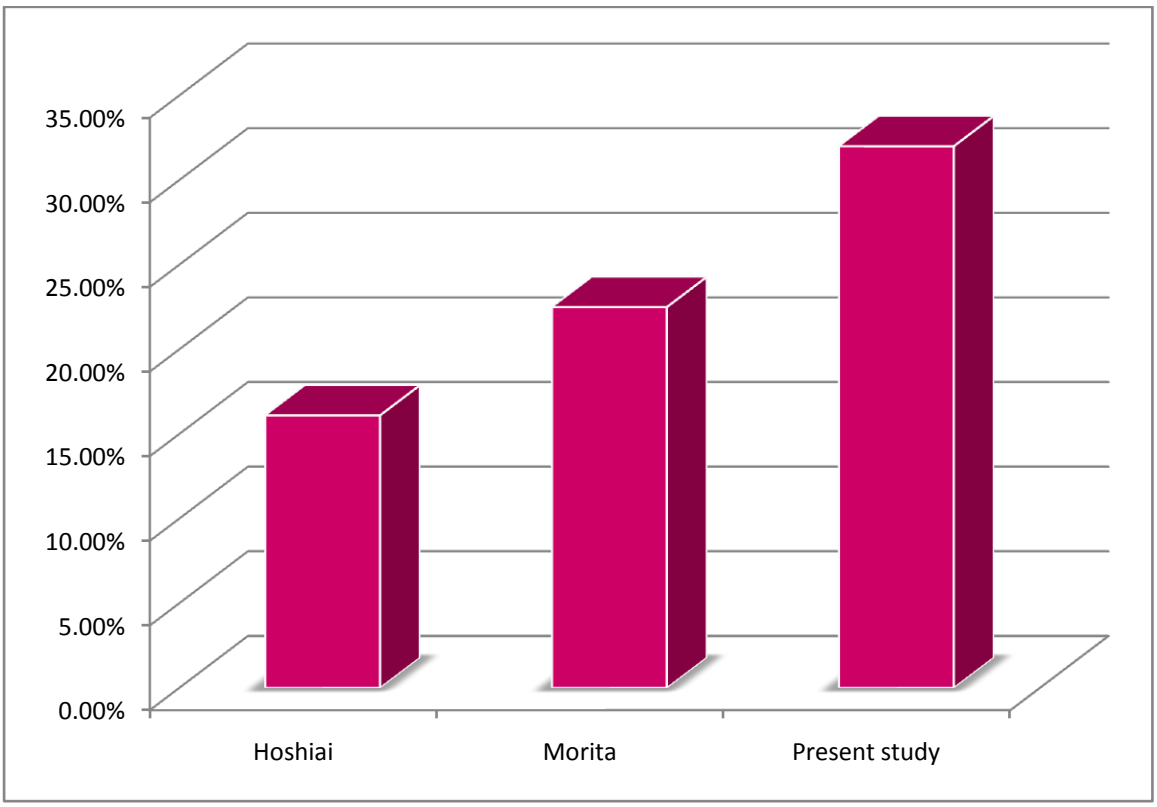
Graph 16: Comparing the type III of adult branching pattern among various authors in wet pelvic specimens



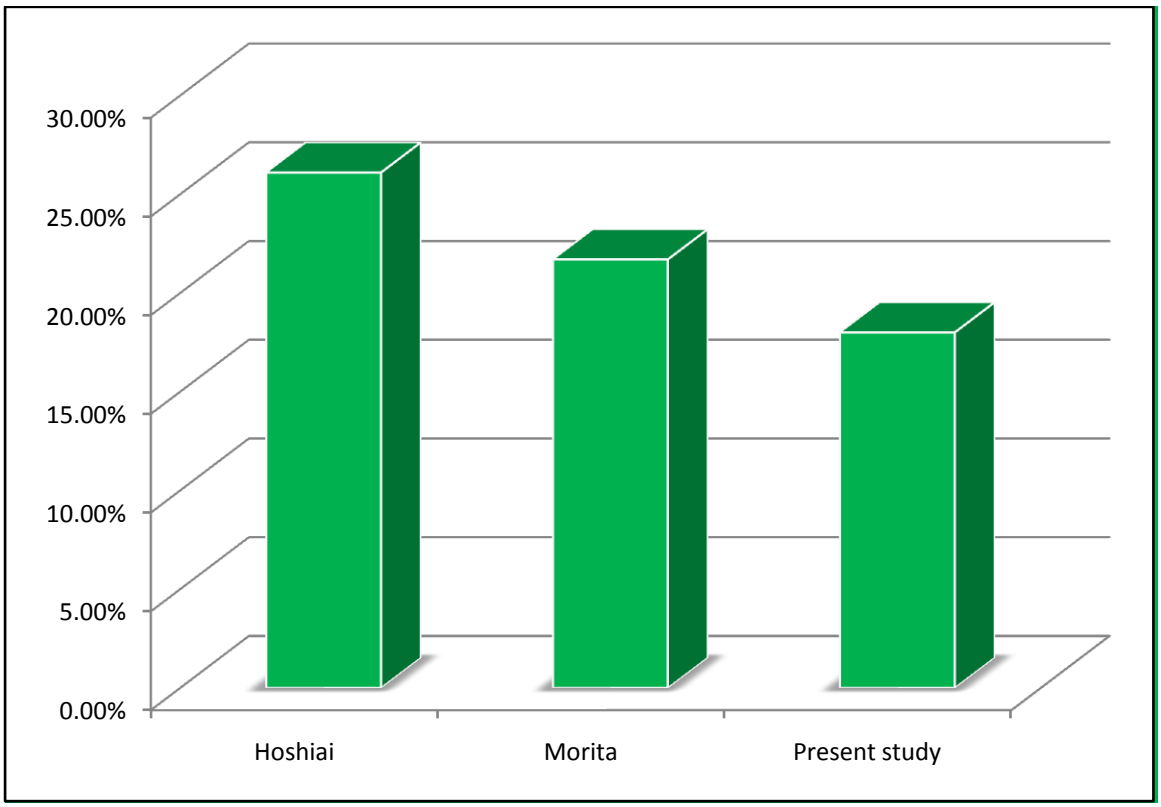
Graph 17: Comparing the type IV of adult branching pattern among various authors in wet pelvic specimens



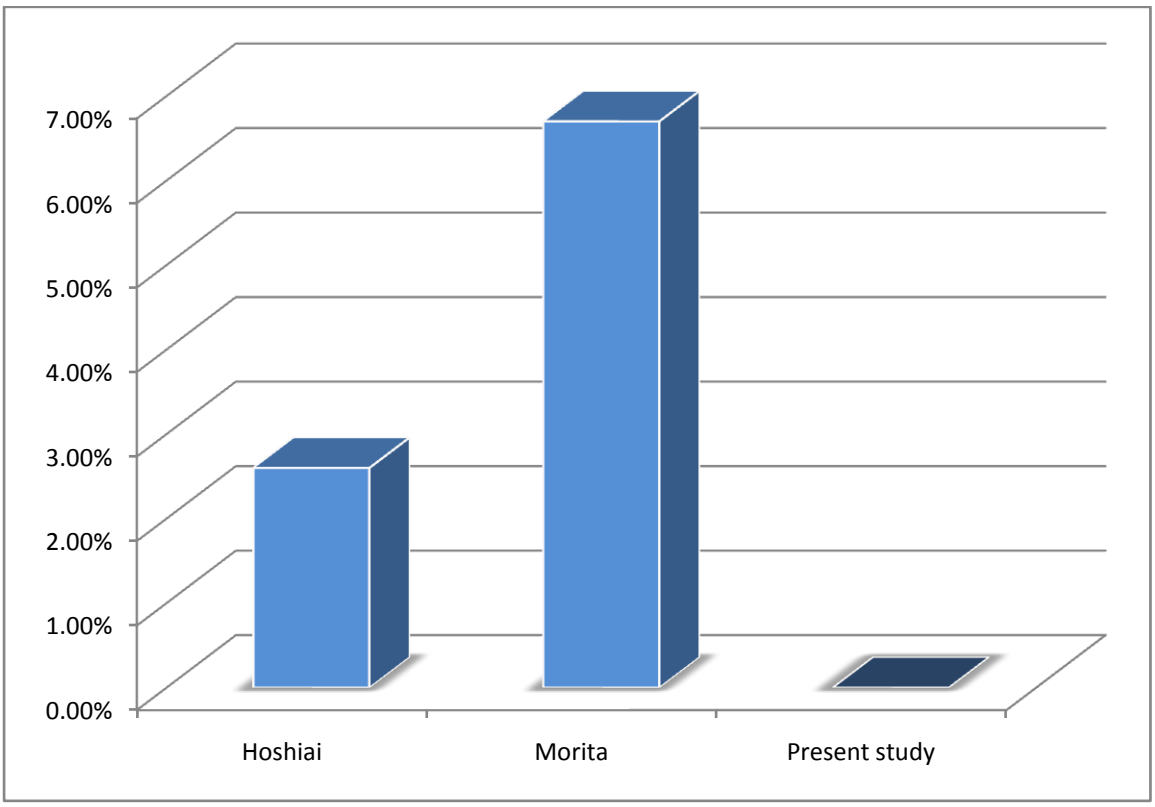
Graph 18: Comparing the type I branching pattern among various authors in aborted foetus



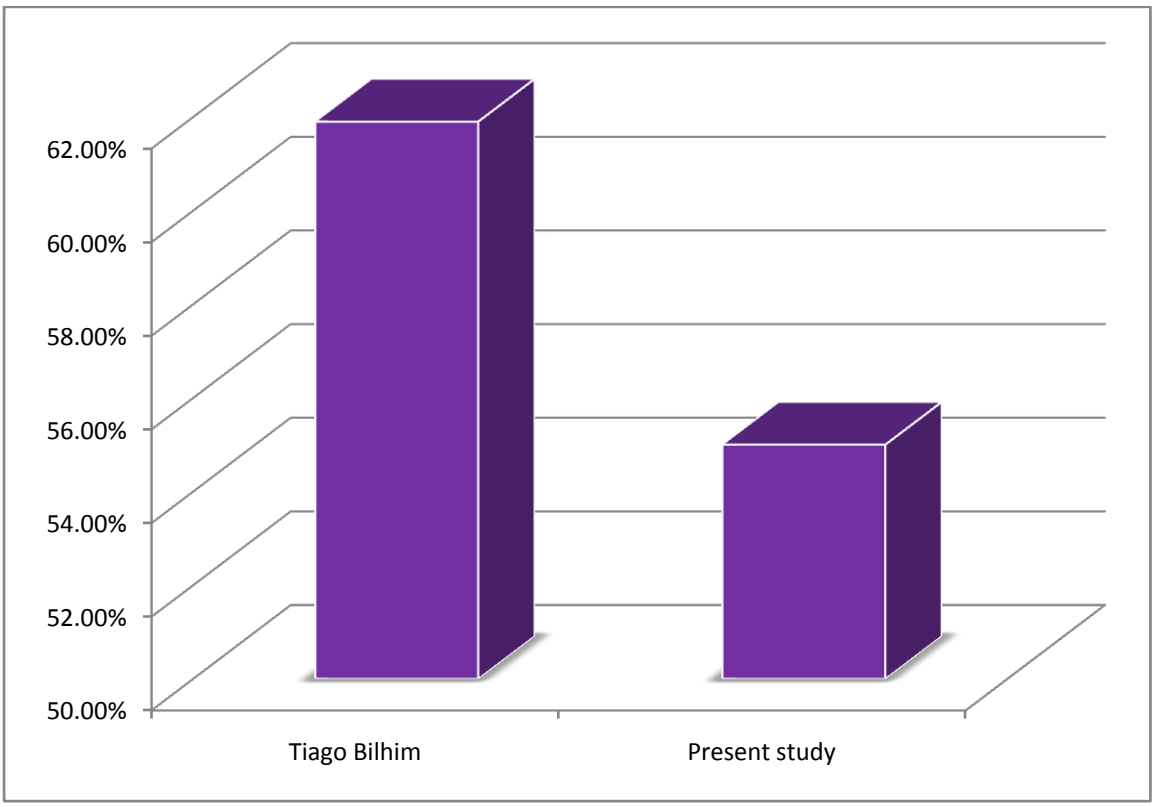
Graph 19: Comparing the type II branching pattern among various authors in aborted foetus



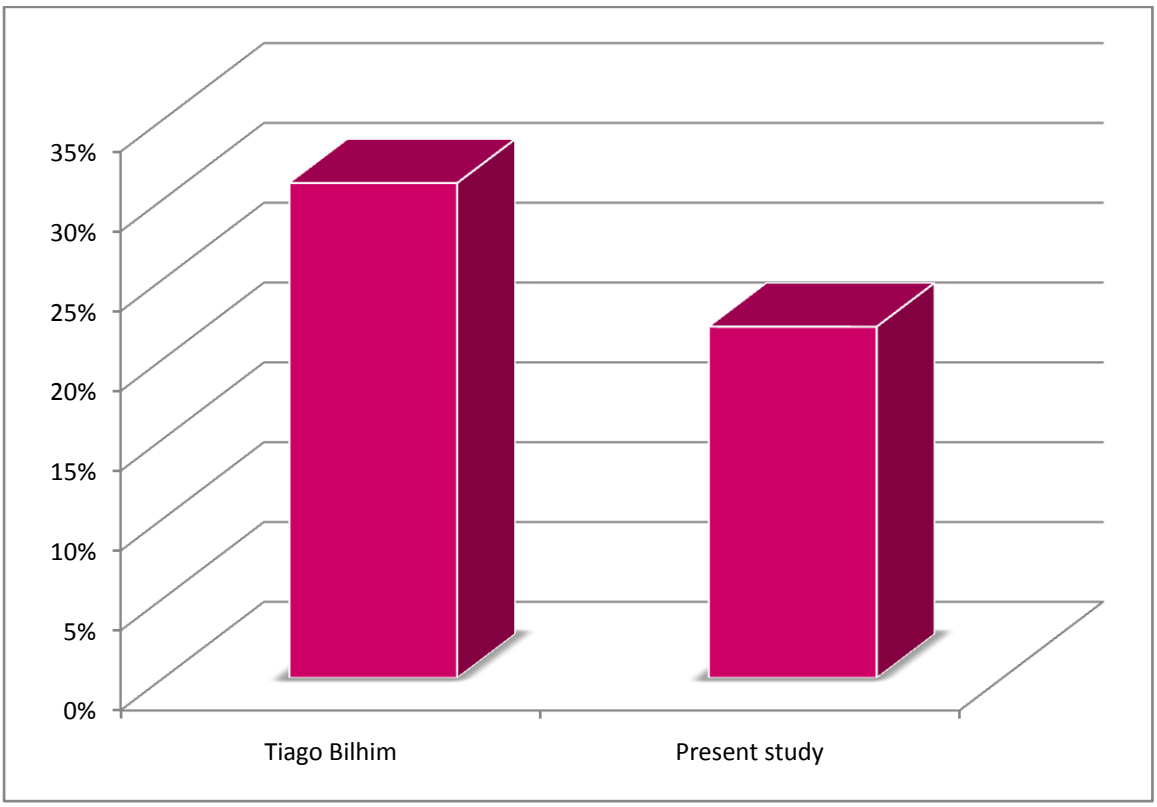
Graph 20: Comparing the type III branching pattern among various authors in aborted foetus



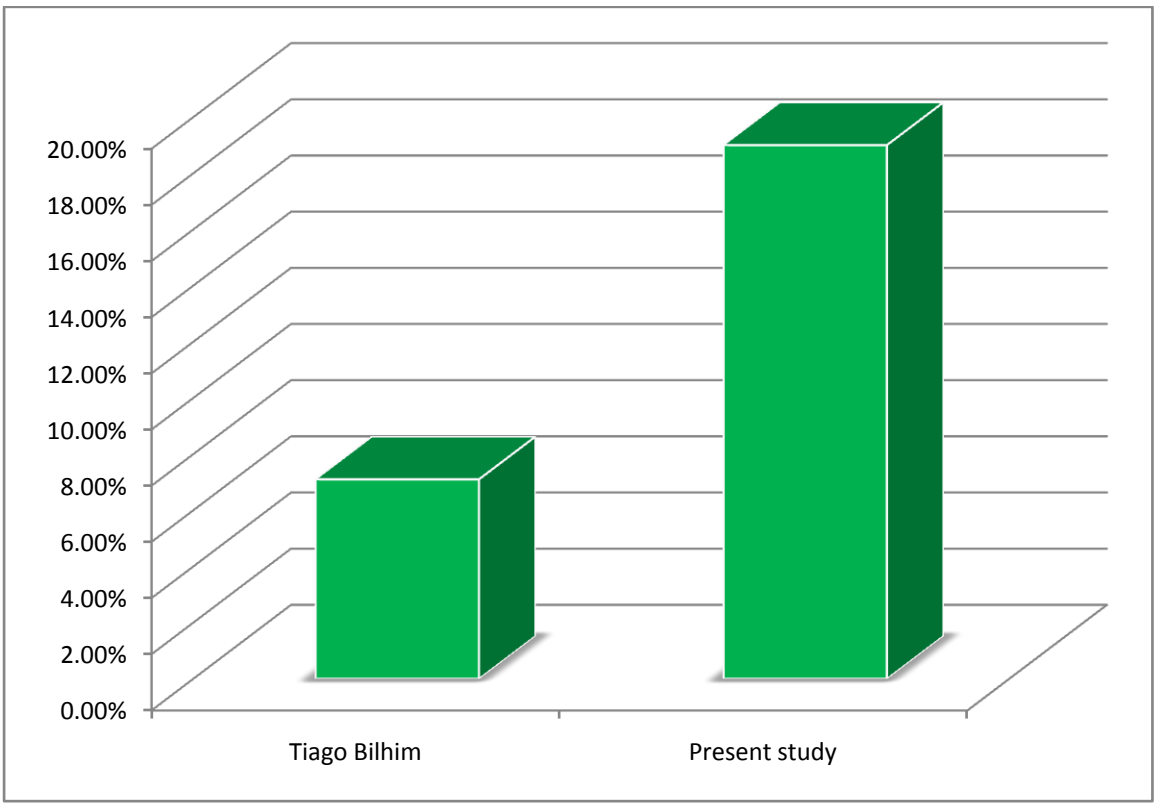
Graph 21: Comparing the type IV branching pattern among various authors in aborted foetus



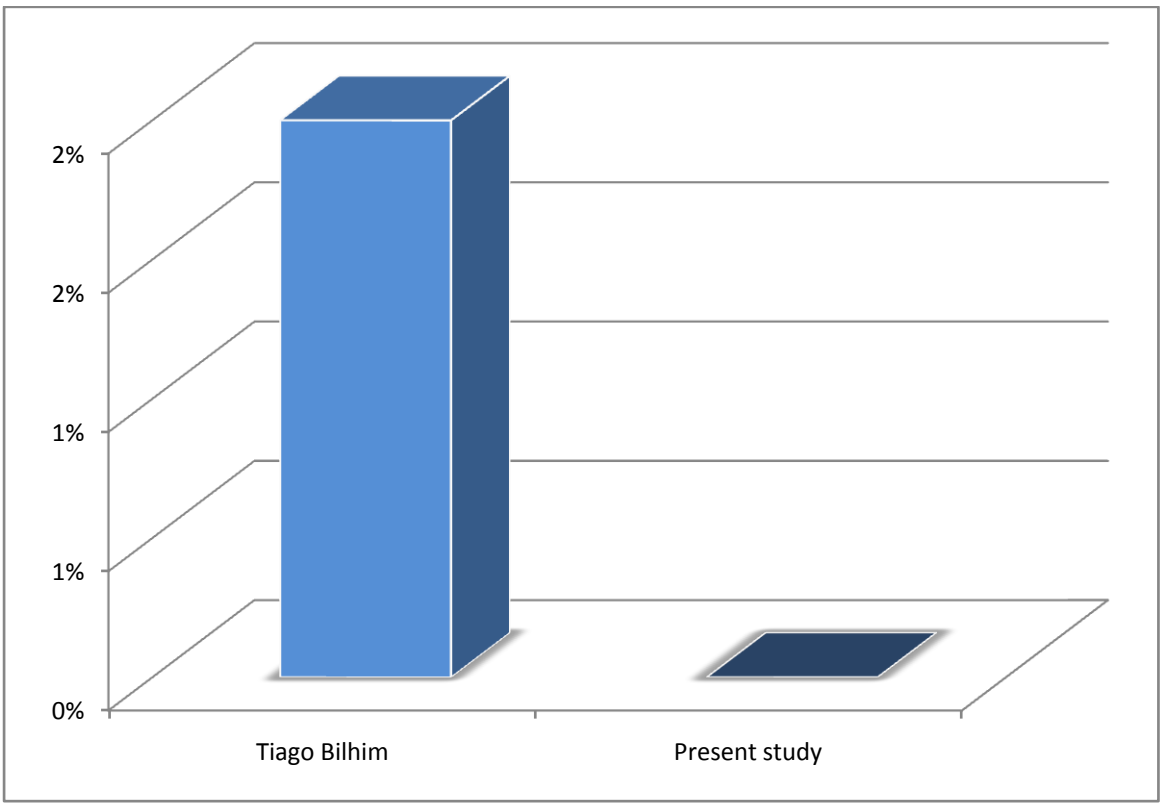
Graph 22: Comparing the group A branching pattern among various authors in CT angiogram



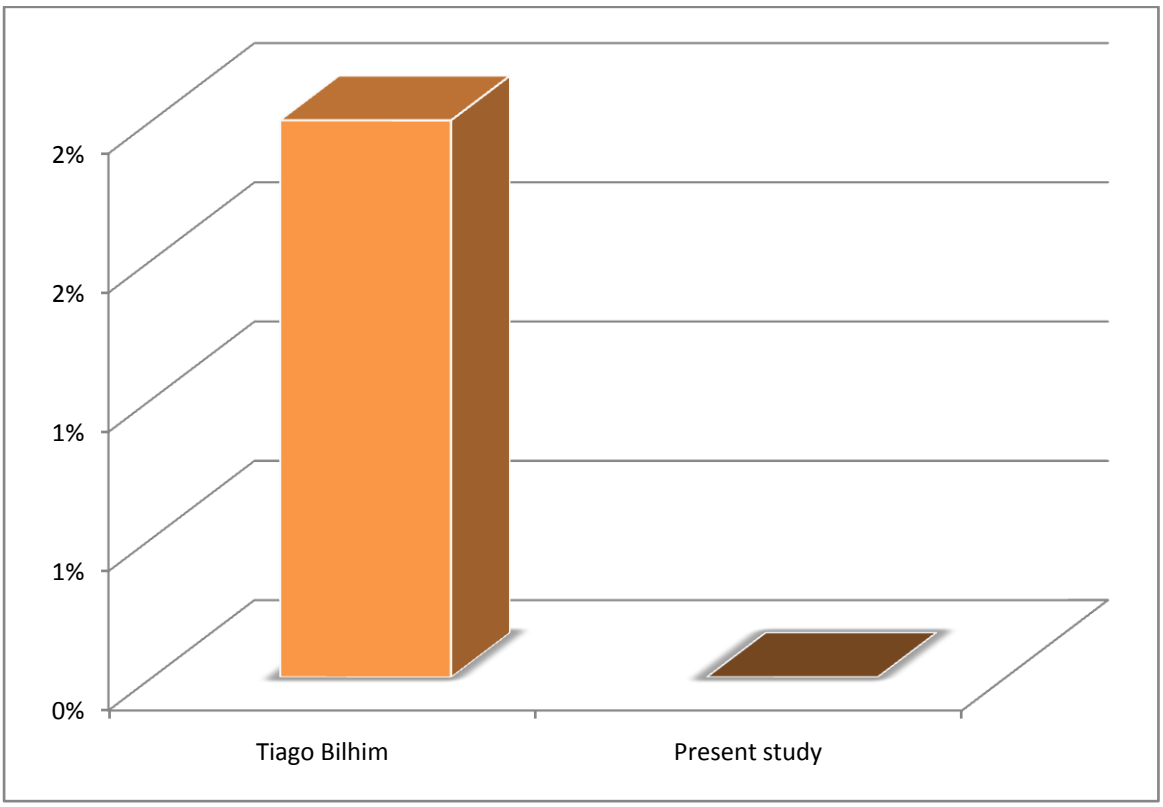
Graph 23: Comparing the group B branching pattern among various authors in CT angiogram



Graph 24: Comparing the group C branching pattern among various authors in CT angiogram



Graph 25: Comparing the group D branching pattern among various authors in CT angiogram



Graph 26: Comparing the group E branching pattern among various authors in CT angiogram

CONCLUSION

Leonardo Di Ser Piero Da Vinci, the Florentine artist (1452-1519) said, the love of knowledge and research was the keynote of both artistic and scientific endeavors. He first recognised the importance of blood supply for penile erection an epic work, which stimulated many of the developments of modern science. In 1923, the French surgeon Lireche first described arterial vascular impotence in the syndrome of thrombotic obliteration of the aortic bifurcation. During the following years several operative strategies were developed to save or reconstruct the internal iliac artery during the abdominal and pelvic vascular surgery.

The angioarchitecture of the internal iliac artery and its branches is necessary for anatomists, surgeons, obstetrics and gynaecologists, urologists and vascular surgeons. The application of the anatomical knowledge in this radiological era for analysing radiological images is needed. Considering the above, the study was done not only on the adult pelvic cadaveric specimens but on the radiological images of the live patients too.

The present descriptive study was conducted in total on two hundred and fifty specimens which includes fifty adult wet pelvic specimens, hundred spontaneously aborted foetus specimens and hundred CT pelvic arteriogram images of live individuals.

To understand the anatomical variations in the branches of internal iliac artery, many researchers have done their study on foetal internal iliac artery to

correlate it with the adult pattern. The persistence of sciatic artery or umbilical artery in the developing internal iliac system causes atherosclerosis in mature individuals. Very few previous studies are available about the variable pattern of internal iliac artery, which determines the adult pattern if persists after 5 months of gestation. Considering the above, the current study was extended to include foetuses between 5 to 9 months of intrauterine life.

In all these specimens, the observation was done based on the branching patterns of three large branches of internal iliac artery and those were the superior gluteal artery, inferior gluteal artery and internal pudendal artery.

a) ADULT WET PELVIC SPECIMENS:

The analyses of the results were based on Yamaki classification [76] in adult pelvic specimens. The results of the current study confirmed that type Ia was the most common type and type V was the least common. Type IV, though was present in female but absent in male considered as significant.

b) SPONTANEOUSLY ABORTED FOETAL SPECIMENS:

As per the Piersol guidelines [51], the analysis of one hundred spontaneously aborted foetus specimens was done. The analysis showed that the most significant type was type I and the insignificant one was type IV. The variations in the arterial branching pattern may be due to the defective arteriogenesis during 3^{rd} to 4^{th} month of intrauterine life.

c) CT PELVIC ARTERIOGRAM:

Based on Yamaki classification [76], the analysis was made on one hundred CT pelvic arteriogram images of live individuals. The analysis concluded that the most common type in Tamilnadu was type A and the less common one was type E.

The alterations in the normal arterial anatomy in this region have its own impact in the surgeries of this region. This knowledge will help the departments of obstetrics and gynaecology, surgery, urology, radiology while performing internal iliac artery ligation or angiographic embolization.

The knowledge of the branching pattern of internal iliac artery is necessary for radiological interpretation and avoidance of mishaps.

FUTURE SCOPE OF THE STUDY:

To analyse the incidence of different types of internal iliac artery branching pattern, the study may be extended by including more number of specimens from different parts of Tamilnadu.

The number of radiological samples may be increased to have more knowledge regarding the branching patterns.

To learn more about the aetiology behind the variations, more foetal specimens from different parts of Tamilnadu may be studied.

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Adult cadaveric specimens- DATA SHEET							
Token No.	I a	Ib	IIa	IIb	III	IV	V
1.	P	0	0	0	0	0	0
2.	P	0	0	0	0	0	0
3.	P	0	0	0	0	0	0
4.	P	0	0	0	0	0	0
5.	P	0	0	0	0	0	0
6.	P	0	0	0	0	0	0
7.	P	0	0	0	0	0	0
8.	P	0	0	0	0	0	0
9.	P(F)	0	0	0	0	0	0
10.	0	0	0	0	P	0	0
11.	P	0	0	0	0	0	0
12.	0	P	0	0	0	0	0
13.	P	0	0	0	0	0	0
14.	P	0	0	0	0	0	0
15.	P	0	0	0	0	0	0
16.	P	0	0	0	0	0	0
17.	P	0	0	0	0	0	0
18.	0	0	0	0	0	P(F)	0
19.	P	0	0	0	0	0	0
20.	P	0	0	0	0	0	0
21.	0	0	0	0	P	0	0
22.	0	0	P	0	0	0	0
23.	P	0	0	0	0	0	0
24.	0	P	0	0	0	0	0
25.	P	0	0	0	0	0	0
26.	P	0	0	0	0	0	0
27.	P(F)	0	0	0	0	0	0
28.	0	0	0	0	P	0	0
29.	P	0	0	0	0	0	0
30.	P	0	0	0	0	0	0
31.	P	0	0	0	0	0	0
32.	P(F)	0	0	0	0	0	0
33.	0	0	0	P	0	0	0
34.	0	0	0	0	P	0	0
35.	P(F)	0	0	0	0	0	0
36.	0	0	P(F)	0	0	0	0
37.	P	0	0	0	0	0	0
38.	P	0	0	0	0	0	0
39.	P	0	0	0	0	0	0
40.	0	0	P(F)	0	0	0	0
41.	P	0	0	0	0	0	0
42.	P	0	0	0	0	0	0
43.	P	0	0	0	0	0	0
44.	P	0	0	0	0	0	0
45.	0	0	0	0	P	0	0
46.	0	0	P	0	0	0	0
47.	P	0	0	0	0	0	0
48.	P	0	0	0	0	0	0
49.	P	0	0	0	0	0	0
50.	P	0	0	0	0	0	0

Foetal internal iliac artery specimens – DATA SHEET				
Token no	I	II	III	IV
1.	P	0	0	0
2.	P	0	0	0
3.	0	p(f)	0	0
4.	0	p(f)	0	0
5.	P	0	0	0
6.	0	0	P	0
7.	0	0	p(f)	0
8.	0	0	p(f)	0
9.	0	p(f)	0	0
10.	0	p(f)	0	0
11.	0	0	p(f)	0
12.	0	0	p(f)	0
13.	P	0	0	0
14.	P	0	0	0
15.	P	0	0	0
16.	P	0	0	0
17.	P	0	0	0
18.	P	0	0	0
19.	P	0	0	0
20.	P	0	0	0
21.	P	0	0	0
22.	P	0	0	0
23.	0	p(f)	0	0
24.	0	p(f)	0	0
25.	0	0	p(f)	0
26.	0	0	p(f)	0
27.	P	0	0	0
28.	0	P	0	0
29.	0	P	0	0
30.	0	0	P	0
31.	p(f)	0	0	0
32.	p(f)	0	0	0
33.	P	0	0	0
34.	P	0	0	0
35.	0	P	0	0
36.	0	P	0	0
37.	P	0	0	0
38.	P	0	0	0
39.	P	0	0	0
40.	0	P	0	0
41.	0	p(f)	0	0
42.	0	p(f)	0	0
43.	P	0	0	0
44.	P	0	0	0
45.	p(f)	0	0	0
46.	0	p(f)	0	0
47.	0	0	P	0
48.	P	0	0	0
49.	P	0	0	0
50.	0	0	P	0

51.	P	0	0	0
52.	P	0	0	0
53.	0	P	0	0
54.	P	0	0	0
55.	p(f)	0	0	0
56.	p(f)	0	0	0
57.	0	p(f)	0	0
58.	0	0	P	0
59.	P	0	0	0
60.	P	0	0	0
61.	P	0	0	0
62.	0	P	0	0
63.	0	p(f)	0	0
64.	p(f)	0	0	0
65.	0	P	0	0
66.	0	P	0	0
67.	0	P	0	0
68.	0	p(f)	0	0
69.	0	p(f)	0	0
70.	0	P	0	0
71.	P	0	0	0
72.	P	0	0	0
73.	P	0	0	0
74.	p(f)	0	0	0
75.	p(f)	0	0	0
76.	0	0	P	0
77.	0	0	P	0
78.	0	P	0	0
79.	P	0	0	0
80.	0	P	0	0
81.	0	P	0	0
82.	P	0	0	0
83.	0	P	0	0
84.	0	0	P	0
85.	P	0	0	0
86.	P	0	0	0
87.	0	P	0	0
88.	0	P	0	0
89.	P	0	0	0
90.	P	0	0	0
91.	0	P	0	0
92.	0	0	P	0
93.	0	P	0	0
94.	P	0	o	0
95.	0	0	P	0
96.	P	0	0	0
97.	0	0	P	0
98.	0	0	P	0
99.	P	0	0	0
100.	P	0	0	0

CT pelvic angiogram – DATA SHEET					
Patient No.	A	B	C	D	E
1.	P	0	0	0	0
2.	0	P	0	0	0
3.	P	0	0	0	0
4.	P	0	0	0	0
5.	P	0	0	0	0
6.	P	0	0	0	0
7.	P	0	0	0	0
8.	P	0	0	0	0
9.	P	0	0	0	0
10.	P	0	0	0	0
11.	P	0	0	0	0
12.	0	0	P(F)	0	0
13.	P	0	0	0	0
14.	P	0	0	0	0
15.	P	0	0	0	0
16.	0	0	P	0	0
17.	P	0	0	0	0
18.	P	0	0	0	0
19.	0	0	0	0	P
20.	P(F)	0	0	0	0
21.	P(F)	0	0	0	0
22.	0	P	0	0	0
23.	0	0	P	0	0
24.	0	0	P	0	0
25.	P	0	0	0	0
26.	0	0	P	0	0
27.	P	0	0	0	0
28.	0	0	P	0	0
29.	P	0	0	0	0
30.	P	0	0	0	0
31.	0	0	0	P	0
32.	0	0	P	0	0
33.	0	0	P	0	0
34.	P	0	0	0	0
35.	P	0	0	0	0
36.	P	0	0	0	0
37.	0	P	0	0	0
38.	0	P	0	0	0
39.	0	P	0	0	0
40.	0	P	0	0	0
41.	0	0	P	0	0
42.	0	P	0	0	0
43.	P	0	0	0	0
44.	P	0	0	0	0
45.	0	0	P(F)	0	0
46.	P(F)	0	0	0	0
47.	P	0	0	0	0
48.	0	P	0	0	0
49.	0	0	P	0	0
50.	0	P	0	0	0

51.	P	0	0	0	0
52.	0	0	P	0	0
53.	P	0	0	0	0
54.	P	0	0	0	0
55.	P	0	0	0	0
56.	0	P	0	0	0
57.	0	P	0	0	0
58.	0	P	0	0	0
59.	0	0	P	0	0
60.	0	0	P	0	0
61.	P	0	0	0	0
62.	P	0	0	0	0
63.	P	0	0	0	0
64.	P	0	0	0	0
65.	P	0	0	0	0
66.	P	0	0	0	0
67.	0	0	P	0	0
68.	0	0	P	0	0
69.	0	P	0	0	0
70.	P	0	0	0	0
71.	P	0	0	0	0
72.	P	0	0	0	0
73.	P	0	0	0	0
74.	0	0	P(F)	0	0
75.	P(F)	0	0	0	0
76.	0	P	0	0	0
77.	P	0	0	0	0
78.	P	0	0	0	0
79.	0	0	P	0	0
80.	0	P	0	0	0
81.	0	P	0	0	0
82.	0	P	0	0	0
83.	0	P	0	0	0
84.	P	0	0	0	0
85.	P(F)	0	0	0	0
86.		0	0	0	P(F)
87.	P	0	0	0	0
88.	0	0	P	0	0
89.	0	P	0	0	0
90.	0	P	0	0	0
91.	P(F)	0	0	0	0
92.	P(F)	0	0	0	0
93.	P	0	0	0	0
94.	P	0	0	0	0
95.	P	0	0	0	0
96.	P	0	0	0	0
97.	0	P	0	0	0
98.	0	P	0	0	0
99.	0	0	0	P	0
100.	P	0	0	0	0